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NEW YORK, OCTOBER, 1894.

ANNOUNCEMENT.

AMONG the many "congresses" which were held last summer in Chicago was an International Conference on Aerial Navigation, which proved to be successful and interesting beyond expectation. In order to make the Proceedings of that Conference accessible to readers who were interested in the subject, the AMERICAN ENGINEER issued a monthly supplementary publication called AERONAUTICS. As these Proceedings have all been printed, and, owing to insufficient support, that journal has been discontinued, and as many of its subscribers and others have manifested a great deal of interest in the paper, and have expressed a desire that some publication of that kind should be continued, and as the science and art of Aerostation is attracting more attention from intelligent people, Aeronautics will hereafter be made a supplementary subject in the AMERICAN ENGINEER. Under that heading it is intended to give the most recent reliable information, relating to the science or art of Aerostation, which indicates any real advance in that direction, or any increase in our knowledge of either the theory or the art of navigating the air. As special space will be devoted to that subject, those readers who are not interested in it can exercise the inestimable privilege of skipping it, and of vituperating those who are as lunatics and "cranks."

To those engaged in the investigation of the principles or practice of Aerostation an invitation is extended to send us data and reports of the results of their researches and experiments, or drawings, photographs, or other illustrations of interesting apparatus. The subjects concerning which we desire contributions do not include mere speculative schemes or mathematical calculations; and it is intended especially to emphasize the fact that the publisher of this paper is not in any sense a "promoter" of such or any other projects excepting his own, and that he has no facilities nor aptitude for raising money for purposes of that kind, and has never acquired the peculiar faculty by the exercise of which the confidence of capitalists is secured.

The paper is his sole and exclusive property, and it is not the organ nor under the influence or control of any association or interest whatsoever, and will represent only the views and opinions of its owner and editor; and the injunction of a distinguished journalist "never to print a paid advertisement as news matter" will be scrupulously observed.

The co-operation of its subscribers and readers is solicited, to extend the circulation of the paper, during the coming year, into wider fields of influence and usefulness. They can aid materially by sending in either new subscribers or the names and addresses of persons likely to be interested in a journal such as it is hoped and intended the AMERICAN ENGINEER will hereafter be.

M. N. FORNEY, 47 Cedar Street, New York.

EDITORIAL NOTES.

IN another column we reprint a letter written to a contemporary regarding the electrical distribution of power. It presents a fair summary of the advantages of the new method of transmission of power over the old; but the writer allows himself to be carried away by his enthusiasm when he states that 80 per cent. of the power developed by the engine "is usefully employed by the machines." This percentage is so far above anything ever obtained in practice, that the statement would deceive no one. The article stands, therefore, as an argument in favor of electrical transmission from the general facts of the case rather than from particular details of the work done.

LOCOMOTIVE engineers are frequently called upon to act quickly or not at all; their work is of a kind that tends to develop coolness, presence of mind, nerve, or whatever else you may choose to call that which enables a man to do the proper thing in the face of an impending calamity; but the quality displayed by some of the engineers in the Northwest during the recent forest fires is of a higher order of bravery—that is, heroism of the first rank. No one who has not faced one of those terrific fires in the pines can imagine the heat and terror of it; and to deliberately take a train of cars into such a place to rescue people imprisoned by the flames is a deed that deserves praise beyond the power of words to convey.

IT appears, from the recent comments of English papers, that the British Admiralty is experiencing some trouble in securing the services of competent men for the engineer's department in their vessels. The trouble lies in the ranking of the line and engineer officers. The latter object to the position which they are obliged to occupy; and men thoroughly qualified to fill the positions will not accept them. It is the same trouble that our own department is experiencing, and against which Commodore Melville has so often protested. The engines of a modern battleship are no longer auxiliary attachments, but the very life of the vessel; and it cannot be long before the men in charge of them will be recognized as entitled to a rank equal to that of officers of the line.

RAILWAY officials who are overwhelmed with applications to "try a new coupler" often wonder why so many men who know nothing about railroading should be applicants for patents on car couplers. The explanation is comparatively simple. For years there have appeared in the daily press paragraphs like the following, recently published in a Pittsburgh paper: "There is a fortune in sight for the genius who

invents a safety car coupler. Patents are issued every day for such devices, but they are anything but safe in practical use." The article then goes on to enumerate the terrible loss of life and limb from coupling cars, leaving the impression that if only a safe and sure automatic coupler could be invented, this holocaust would be stopped ; and straightway the butcher, the baker, and the candlestick-maker proceed to invent a coupler that will be a boon to humanity and incidentally a fortune unto themselves. Some time ago the Patent Office issued a circular letter in which it was announced that no patent would be granted upon a flying machine until it had been practically demonstrated that the said machine would fly. It may be impossible, but it seems that it would be a good idea to call a halt on car couplers. They have been issued at the rate of a trifle over one each day for several years, and, to judge from the conversation of the majority of railroaders, we have about enough.

THE PROCEEDINGS OF THE MASTER MECHANICS' ASSOCIATION.

II.

Last month we commenced a general review of the Report of the Annual Convention of this Association, which had then just been issued by the Secretary in book form with commendable promptness. Resuming this review, which was left off at the point where the discussion of compound locomotives was commenced. This discussion was a sequence to a resolution that the convention resolve itself into "a compound experience meeting" at noon—the hour set apart for topical discussions—on the first day's session. The remarkable feature brought out by this discussion was the great difference of opinion which it revealed with reference to the compound system. A few quotations will show this difference. Mr. Garstang, for example, said of a locomotive built by the Richmond Locomotive Works, and which had been in use on his road since last December, and ran "first in and first out," that it did not require any special engineer to handle it and that there had not been "an outlay of one cent on the mechanism connected with the compound feature."

Mr. Vauclain, who, in connection with the Baldwin Locomotive Works, has had, probably, more experience in the construction of compound locomotives than any other person, said that they "had no reason whatever to change their minds in regard to the adaptability of compound locomotives to all classes of service."

Mr. Lauder—whose death since then we and many of our readers have had occasion so recently to lament—agreed with what Mr. Vauclain had said, in thinking that "the compound locomotive will do as great a variety of work as the simple engine. On suburban business, when the trains range from seven to ten cars, and have nine stops in 11 miles, the compound engine (Dean's) he thought would 'get away with' any simple engine they had in the service," and he added that he "did not know of any kind of service that the compound locomotive is not well adapted to. . . . The extra cost of maintenance will be something, no matter what interested parties may say ; whether we will get enough out of our saving in coal to pay for these extras in the way of other expenses is still to be determined. . . . I think it is perfectly safe to say that we are going to have a compound locomotive in which we can safely count on a saving of 20 per cent. over the best simple engine that can be built. I am satisfied that we are going to get—we have not got it yet—an engine that will give us a saving of about 20 per cent. *But to get that saving the compound locomotives must be kept in better condition than we have been in the habit of keeping our simple engines.*"

Mr. W. S. Morris, of the Chesapeake & Ohio Railroad, said of an engine built by the Richmond Locomotive Works, and which has been operated on his road, that "it had no increased steam pressure over 10 ordinary simple engines. The mileage for the year 1893 made by the compound was 14 per cent. greater than the average mileage of the 10 simple engines. The total cost of repairs was 80 per cent. of the total cost of the average of the 10 simple engines. The oil and waste consumed was 92 per cent. of the average of the 10 simple engines. The fuel consumed was 84 per cent. of the average of the 10 simple engines. The total expenses of the engine, including everything, was 94 per cent. of the total of the 10 simple engines, and the cost per mile run, in cents, was 83 per cent. of the average of the 10 simple engines. The days in the shop during the year were five as against 10 for the average of the other 10 engines. The engineer states that he did not have any difficulty whatever in running the engine in any service that it has been placed in. That will refer to general freight service, local and through. The firemen all seem to have a special liking for the machine, and their reason is that it burns less coal, which is a very practical reason for concluding that the engine is saving in that direction. The shop expenses, I will say, although the average for the year shows a little less than the average for the 10 simple engines, are about the same."

Mr. John Medway, of the Fitchburg Road, said his experience "had been largely with one 2-cylinder compound ordered with four others in 1893. The simple engines were almost precisely like the compound except with regard to the compound devices. At first the compound showed a saving of 23 per cent. in fuel. Later on, for some reason, the fuel economy was reduced and almost entirely disappeared. For the 6 months ending September, 1893, the showing was as follows : Cylinders of compound, 21 in. and 31 × 26 in. ; of simple engine, 20 × 24 in. Steam pressure : Compound, 180 lbs ; simple, 180 lbs. Miles run : Compound, 12,794 ; simple, 19,366. Miles per ton of coal : Compound, 25.1 ; simple, 22. Repairs, cost per mile, in cents : Compound, 2.75 ; simple, 1.28."

Mr. A. E. Mitchell reported that they had eight compound Baldwin engines, and that "the results show material saving in coal, no greater expense in repairs due to the running, and the engineers prefer them to the simple engine."

This discussion was resumed on the last day of the convention. Mr. A. E. Manchester, of the Chicago, Milwaukee & St. Paul Road, referring to engine No. 827, concerning which a report of tests had been submitted to the Association last year, said : "An examination of the records a few weeks ago showed the fact that No. 827 was leading the other nine engines of the same make and bought at the same time, about 11 per cent. in economy of fuel consumption. Its repair account was a trifle cheaper than the average of the other nine."

Mr. George Gibbs, also of the Milwaukee Road, referring to the same engine, said : "It was a particular child of mine, inasmuch as I have spent a good deal of time in conducting tests of that engine in connection with the Association committee. . . . I have this year been watching with some care to see whether the results of these tests were borne out by the additional service we have got from the engine. My impression was at that time, and we concluded that the average economy was about 13 per cent. . . . In the first 6 months of the year it went up to over 17 per cent. higher than the average of the other nine engines. During the last 3 or 4 months, however, I notice that it has fallen considerably, and that the figures are now as mentioned by Mr. Manchester. I believe the explanation of that is, that the valves are beginning to need overhauling. . . . I certainly believe that the compound engine is in every way adapted to a varied class of freight service ; that its economy will be found larger than that found on our road in average service. I believe a properly designed compound engine will be light on repairs—as light as the simple engine—and that it is the coming type of engine for freight service in this country."

Mr. E. A. Miller, of the New York, Chicago & St. Louis Road, said: "The compound"—in use on their road—"has shown a saving of fuel of about 1 lb. of coal per car per mile. What we would call the running repairs, the light, every-day repairs, will average about the same as they do on the same class of simple engines. We have had a number of breakages on the compound that have been very much against it. The engine has been laid up a good part of the time."

Mr. William Forsyth.—"Our experience with compound locomotives is limited to very few engines, but it extends over a rather long period of time, and the conclusions in general which we made are that the repairs of the compound locomotive, when properly constructed, should not be any greater than the simple engine, and that the economy in coal should be a clear saving. The original engine which we designed and built at Aurora with the Lindner starting gear is still in service, showing good economy. The principal troubles we have had with it are with the piston packing of the large cylinder. I think that trouble has been general with most large cylinders. It is difficult to get a snap ring of good iron in proper proportion which will retain this spring and hold the packing tight; and it sometimes breaks and sometimes gets in shape so that it cuts the cylinder, and that is one trouble that we have had with this large cylinder.

"Another small objection is the difficulty in handling. That is the fault of the starting gear. The men, in running the engine on to a turn-table and out to the roundhouse, find that they cannot handle it as readily as they can the simple engine. We made quite an expensive test of a Baldwin compound, and last summer we tested a Richmond 10-wheeled compound, and I must say we were very much pleased with the performance of that engine on the grades of Iowa, hauling heavy freight trains, and that we found the special feature of the separate exhaust in that engine quite an advantage in working freight trains on a grade. It has two advantages: one is, that it allows you to turn the engine into a simple engine and overcome that objection to the Lindner gear. At the same time it allows you to throw an extra power into the engine by using live steam in the low-pressure cylinder when hauling heavy trains on grades."

Mr. G. R. Joughins, of the Norfolk Southern, reported that they had two compound locomotives on their road. "We all know," he said, "that there are about a dozen devices, each of which save about 10 per cent. on the locomotive if they are applied to it—that is, according to the statements of the people who sell them. But the compound system is the only device which I have seen applied to a locomotive which saves coal every month and every week in the year, and we are very well satisfied with it."

Mr. Bradley said they "were satisfied that their compound engines on the car mileage show about 18 per cent. of fuel economy."

Mr. David Brown.—"At Lakewood I stated that we had a Baldwin compound and a new simple engine of about the same capacity, and that the simple engine was giving the best satisfaction, and that we had given them a test on a heavy pull, also on a fast passenger train up the mountain, and also a coal test; in each case the results were in favor of the simple engine, and also that the compound was not a favorite, owing to her hard riding when running down long grades. Otherwise she has worked well.

"Our yearly report shows a great difference in cost of repairs, oil, etc., between two engines in favor of the simple engine; but this in part is accounted for, as a large per cent. of the repairs on the compound consisted in alterations.

"After 11 months of service we had to take the compound into shop on account of bad tires. The tires were in very bad shape, and we also found that the axle journals were worn eccentric, making it necessary to true up the axles. The piston valves were found in good condition; but we had to put new packing rings in both pistons and valves.

"In the mean time we received another compound from the Cooke Locomotive Works. It is a very fine engine, and I believe she is the most powerful of the three, providing she held her steam as well as the other two. It weighs 6¼ tons more than the others, and for a heavy engine the design and workmanship could hardly be improved upon. . . .

"A coal test was then made between Cooke's compound and the simple engine, which resulted in favor of the simple engine 20 per cent.

"New valves were next put on the Cooke compound with more lap. A coal test was begun between the Baldwin and Cooke engines. The Baldwin compound burned 71 lbs. of coal per mile; the Cooke compound burned 65 lbs. per mile. The difference was very slight, considering that the piston stuffing-box glands on the Baldwin engine were blowing badly at the time. The train consisted of nine milk cars and caboose.

The simple engine was then put on coal test again, which resulted in her favor, burning 52 lbs. per miles, beating the Cooke 20 per cent. and the Baldwin 26 per cent.

"An old 19 × 24 in. engine with 140 lbs. pressure, pulling eight milk cars and caboose, was next tried, and she burned 74 lbs. per mile.

"Recently the by-pass valves on the Baldwin compound have been changed, as stated by Mr. Vauclain, and it has improved her riding very perceptibly."

The most remarkable testimony was then given by Mr. Gibbs, who said that he was "very much surprised by the evidence brought out yesterday and to-day in regard to the economy of compound locomotives. If we closed now it would appear, with the exception of Mr. Brown, who has just spoken, that our unanimous experience has been that the compounds are both economical and available; *but if you buttonhole the members outside, the evidence seems unanimous in the other direction—that they don't believe in compounds.*"

Mr. W. S. Morris added: "I think Mr. Gibbs's point is a very good one. *We can hear a good deal against the compound engine outside the association, but we hear very little against it in the meeting.*"

Mr. J. H. McConnell, of the Union Pacific, stated his view of the question when he said that "when the compound engine came into existence to compete with the simple engine, they put on a boiler that had 33 per cent. more heating surface; they had 33 per cent. more weight on the driving-wheels and 33 per cent. more steam. They put it beside an engine with these disadvantages, and they claimed after 5 years to show an economy of 5 per cent. If they keep on at it long enough I believe that they will eventually get a compound engine that will beat a simple engine of the same size." (*Applause.*)

The discussion was ended by Mr. Soule, of the Norfolk & Western Road, whose careful and accurate statement of facts always commands attention. He remarked: "Mr. McConnell said in part that in every competitive test the compound had had the advantage in many respects; and that two of them, as I understood him, were, that it always carries higher steam pressure and a greater weight on the driving-wheels. I consider, Mr. President, that these are advantages that the compound engine legitimately enjoys. I believe that it is the principle of compounding that has made it possible to use higher pressures economically. I believe that if any master mechanic here present takes one of his simple engines, we will say adapted to carry 160 lbs. pressure, and builds a sister simple engine, making it only enough heavier to carry 200 lbs. pressure, and returns that engine to service in competition with the other, he will find that the latter engine with the higher pressure is not as economical as the first one. I believe it is pretty well established that the common practise of the country, by this long, slow process which we all go through with, has brought us to use that pressure in our simple locomotive practise, which is about right and about the most economical, and that we have got to the end of the rope in that matter.

"Now, then, by introducing the compound principle we are able to utilize economically higher steam pressures. In order to get those higher steam pressures we have to make our engines heavier, and, incidentally, in being able to use the higher steam pressures economically, we are justly entitled to make use of heavier weight on the driving-wheels. . . .

"We have a total of 46 compound engines, 15 of which are 10-wheel passenger engines, and 31 are consolidation freight engines. We have not been without tribulation in this matter, but we regard it as simply incidental to the struggle to get better results, which we feel we are realizing. The 15 compound 10-wheel passenger engines have large wheels. We have found during this period of depression in the last year that we have not got the passenger business to justify such an equipment. Nearly every one of these engines runs, in one direction at least, with a very light train; and we are perfectly confident that we are not deriving any advantage from their use. I think we can almost predict that we shall ultimately cut down the wheels and turn them into freight service. But we base our faith in the compound on the experience that we get with it in freight service. The first batch of 21 consolidation engines were built as recommended by the Baldwin Locomotive Works.

"We found that there was a churning action of the pistons which was damaging to the cylinders, pistons, cross-heads and guides, that arose from the fact that there is undoubtedly at times an unequal load on the high-pressure and low-pressure pistons. . . .

"But under all the varying conditions of locomotive service and all the exacting conditions on a railroad, I think that during a great portion of the time the loads on the pistons are unequal. That has shown itself in the wear of the cylinders and also in the fits where the piston-rods enter the cross head. We have recognized the fact, and in the last 10 engines have carried the low-pressure cylinder rod through to the front cylinder head. After a good many months' service from this lot of engines we think that is a solution of the problem. . . .

"Those facts and figures then presented last year brought out the fact that the expenses incidental to the maintenance of the cylinders, pistons, piston packings and valves constituted only 2¾ per cent. of the total cost of maintaining a locomotive, and, therefore, although we have had a somewhat disastrous experience with our cylinders, nevertheless it is a very slight, insignificant thing, and it is only a featherweight against the real economy that we have derived from the use of the compound principle in freight service, and that economy we believe has been established with us as ranging in the neighborhood of 10 per cent. in water consumption and 20 per cent. in coal consumption. I think we may safely assert that we have reached the point where we have got through with either building or buying simple locomotives for freight service."

We have quoted very freely from this discussion because it is a very interesting one, and the subject is of much importance to railroad companies. The preponderance of testimony brought out by the discussion, it will be seen, is strongly in favor of compound locomotives. Nevertheless, Mr. Gibbs allowed a very active animal (of the genus *Felis*) to escape from his mental sack when he testified that buttonholed members outside the meetings "don't believe in compounds." The inference is, that the unexpressed antithesis would be, that when members are unbuttoned in the meeting they become agnostics so far as compound locomotives are concerned.

On the first day of the meeting a report of the remarkable performance of simple engines on the New York Central Railroad was submitted, in a printed report in which a comparison was made with the astonishing results obtained in a test of Mr. Webb's compound locomotive *Greater Britain*, on the London & Northwestern Railroad. This data was reprinted in the AMERICAN ENGINEER for July, page 295, but for some reason the figures submitted to the Association are not reprinted in its annual report. As the performance of the *Greater Britain*, a compound engine, is the most remarkable of which there is any record, and as it was beaten by that of a simple engine, the figures which recorded it would seem to have sufficient importance to justify their being reprinted in the annual report. The real significance of the test can be shown with a very few figures. The *Greater Britain* made a mileage of 3,612 miles, the average weight of the train of cars being 2.08 times as much as the engine and tender, at an average speed of 47.66 miles per hour, with a consumption of 2.979 oz. of coal per ton (of 2,240 lbs.) of train, exclusive of engine and tender. Engine No. 999, on the New York Central Railroad, ran 1,332 miles, the average weight of its train being 3.06 times as much as that of the engine and tender, the average speed 45.42 miles per hour, and burned only 2.18 oz. per ton per mile. Since the convention was held another test was made on the New York Central Road, a report of which was published in our issue for September, page 423. The same engine is there reported to have run 3,874 miles, at an average speed of 50.5 miles per hour, the average weight of the train of cars being 2.04 times that of the engine and tender, with a consumption of coal of 2.662 oz. per ton of train (exclusive of engine and tender) per mile.

These figures are put forward as a challenge! Where is there a compound locomotive in this country that can equal this performance? We have looked in vain for data which are comparable with these figures. In fact, none of the members who took part in the discussion in Saratoga seemed to realize the significance of the data submitted to them. If these figures can be relied on—and we understand that the authorities of the New York Central Road are prepared to back them up—then the advocates of the compound engines must, in order to sustain their claims of a saving of from 15 to 30 per cent. of fuel, be able to haul trains weighing more than twice as much as the engine and tender at average speeds of over 50 miles per hour, with a consumption of coal of 2.262 to 1.864 oz. per ton per mile. Who can do this?

Our summary has again extended to such length that we are obliged to leave the consideration of a part of the report for another occasion.

NEW PUBLICATIONS.

ADVANCE copy of Contents and Preface of A RECORD OF THE TRANSPORTATION EXHIBITS AT THE WORLD'S COLUMBIAN EXPOSITION OF 1893. By James Dredge. London: Office of *Engineering*; New York: John Wiley & Sons. 52 pp., 10¾ × 14¼ in.

The purpose of the publication of this preface obviously is to announce the forthcoming volume which Mr. Dredge has in preparation, and which will contain 800 pages and 200 plates. The preface gives an outline of the scheme, and also a general description of the plan of the Exhibition and some criticism of its merits and defects. An extended notice of the book itself cannot, of course, be written in advance. Its general scope will, however, be indicated by the following extract from its preface: "The Transportation Exhibits Building," Mr. Dredge says, "appears more deserving of having its contents specially recorded than any other department or group of the Exposition. But to adequately discharge the task a far larger volume than the present would be required. . . ."

The appearance of the complete volume will be looked for with eager anticipation by those interested in the engineering of transportation.

MACHINERY. Vol. I, No. 1.

In what may be called their prologue, the projectors of the new candidate for public favor which is issued by "The Industrial Press" of New York City say that "the cost of almost everything used in connection with such (newspaper) work has declined, so that it is possible to produce to-day a mechanical paper (in editions of sufficient size) for 5 cents a copy superior in every way to what would have cost twice that amount a few years ago." Therefore it is proposed to issue this paper monthly at 50 cents per year, and at 5 cents per number. With this scheme in view, they have issued a well-printed paper of 22 pages, which are a little larger than those of the AMERICAN ENGINEER. It contains articles on the Cramp Ship Yards; Differential Gearing; Throttling *vs.* Automatic Engines; Chimney Draft; Compressed Air in a Railroad Shop; Hints for the Shop; Condensation; Threading Dies; and Notes.

The arrival of a stranger always imposes the duty of extending a welcome. In the present condition of the newspaper business this welcome, however, assumes the character which persons in prison on short allowance would be likely to give to a new convict. Even in prison, the more there are the merrier, probably, but the smaller will be the portions of food and raiment which are to be divided among all of us. Misery is proverbially fond of company, and, therefore, being in the treadmill, the arrival of another batch of convicts cheers us. The list of these includes Fred. H. Colvin, Editor; W. H. Wakeman and Walter L. Cheney, Associate Editors; and F. W. Jopling, Art Editor. We wish you all long life and greater prosperity than some of the rest of us are now enjoying.

NEW ROADS AND ROAD LAWS IN THE UNITED STATES. By General Roy Stone, V.P., National League for Good Roads, and U. S. Special Agent and Engineer for Road Inquiry, Department of Agriculture. New York: D. Van Nostrand Company. 166 pp., 5 × 7½ in.

The author of this book says that the demand for information on its subject generally relates:

1. To the new legislation for road improvement and the working of that legislation.
2. To the cost and methods of road construction.
3. To the efforts of road improvement where it has been accomplished.

The aim of his book, he says further, is "to give a condensed account of recent progress in American road-making, with details of the examples which have been most conspicuously successful, together with some suggestions for legislation and for road construction." The first two chapters set forth various statements and opinions to show the importance of good roads, and an explanation of the nature of the Government Road Inquiry, of which the author has been appointed the special agent and engineer. The next three chapters describe various roads built and methods of construction employed in different parts of the country. Following this are a number of chapters on Road Legislation; State and Railroad Aid in Road-making. After this Materials for Road-making; Methods of Construction; Effects of Wide Tires on Roads; Report of the Ohio Commission; Attitude of Farmers, "Wheelmen" and Commercial Organizations to the Subject of Road-making. The last chapter is on Road-making and the Revival of Business, and the book concludes with Abstracts of New Road Laws in Sixteen States. It is without an index, however—an omission which is unpardonable in any technical book. It is, however, written very clearly, is easy reading, and printed in large, clear type, and is illustrated with a number of half-tone engravings from photographs of roads in different parts of the country.

A Text-book on Roads and Pavements. By Fred. P. Spalding. New York: John Wiley & Sons. 213 pp., 7½ × 5 in.

"The aim of this book," the author says, "is to give a brief discussion, from an engineering standpoint, of the principles involved in highway work, and to outline the more important systems of construction, with a view to forming a text which may serve as a basis for a systematic study of the subject."

There is an academic flavor about this which is not assuring, an impression which is confirmed by the opening chapter, in which the Object of Roads is gravely discussed; and we are told that "a road or street is to provide a way of travel." There is a chapter on General Considerations, another on Drainage, which is followed by one on Location of Roads, in which the reader is informed, on p. 42, that "the determination of a line for a proposed road involves the examination of the country through which the road is to pass." In reading this sage remark one is led to wonder whether any sane person ever located a road *without* examining the country. Again we are told that "changes in the length of a road affect all portions of the traffic in the same manner." How very remarkable it would be if it did not!

Evidently the author is apprehensive that roads may be located without examining the country, because he repeats the fatuous observation on page 53. On reading that "the line must be well designed to accommodate the traffic," one is disposed to ask, "What possible good can be accomplished by printing such twaddle?" The book is full of just such trite observations. The reader is informed, for example, that "footways are not required to bear the heavy loads which come upon the roadway pavement;" "a good sidewalk should present an even surface;" "curbs are usually set in the streets or towns at the sides of roadway pavements;" "there are various ways of setting a curb;" "the grades of city streets necessarily depend mainly upon the topography of the site," etc., *ad nauseam*. It may be said of this book, as of some people, it would perhaps have been better if it had never been born.

Report of the Proceedings of the Twenty-eighth Annual Convention of the Master Car Builders' Association. Held at Saratoga, N. Y., June 12, 13, 14 and 15, 1894. 463 pp., 6 × 9 in., and 16 folded plates.

This report reaches us in its usual form; but, like the Association and the interests it represents, it has grown in bulk, and also in the variety of matter it contains. The present volume contains 54 more pages than that of last year. It is well printed, and great credit is due to the Secretary for the promptness with which it has been issued and its general typographical excellence. In comparing it, though, with the Master Mechanics' report, several things invite comment. In the latter the reports of committees are printed in large type—apparently small pica leaded—and the discussions in smaller type—minion, also leaded. In the Master Car Builders' report this is reversed—that is, the reports and papers are printed in small type—agate, leaded—and one paper—Mr. Rhodes's on Wheel Flanges—is set in pearl leaded. The Master Mechanics' practice seems to be preferable. Agate and pearl type may do for the young chaps who are so rapidly supplanting us old fellows, but those of us whose eyesight is daily becoming less acute will vote for larger type. The general principle to be observed would seem to be to print the most important matter in the largest type. Certainly of the Proceedings the carefully prepared reports are, or may be, expected to be of greater importance than the extemporaneous discussions therein, in which such chunks of wisdom as "I second the motion;" "The convention then adjourned;" "Mr. —— read the following report," etc., form a considerable portion. If the whole of the Proceedings were printed in bourgeois or brevier, with the reports of committees leaded and the discussions set solid, the Proceedings would be pleasanter reading than they now are.

The finances of the Association would seem to admit of using a better quality of paper than the report is printed on. That which is used for both of the reports apparently consists largely of wood pulp, and its existence is probably limited to only a few years. As these reports will be valuable to posterity, it is worth while to print them on material which will not decay and crumble as early as the members of the Association will.

Another criticism is that some of the engravings—notably those of brakes, on pages 33–39—are made on too small a scale. The same thing is true of the standards of the Association at the end of the book; but copies of these are obtainable on an enlarged scale. One of them, though—that of the standard wheel tread and flange on plate 7—would be unintelligible to any person not familiar with its form and dimensions. When there is so much to commend, though, it seems invidious to criticise these minor faults.

Water or Hydraulic Motors. By Philip R. Björling. New York: Spon & Chamberlain. 287 pp., 4¾ × 7½ in.

In his preface the author says that "this book is intended as an introduction only to hydraulic motors." It is certainly a very interesting and useful introduction. It begins with a chapter on Hydraulics which gives some simple facts, principles and data which have a relation to water motors. The rest of the book relates to the following general subjects: Water Wheels; Turbines; Water Pressure or Hydraulic Engines; Hydraulic Rams; and a final chapter on Measuring Water in a Stream and over a Weir.

The author says, "All the books previously published are too abstruse in mathematics, and not practical. This," he says further, "is what I have tried, as much as possible, to avoid."

The general method of treatment of his subject is to describe very briefly, with the aid of a diagram, the various kinds of mechanism included under the different heads embraced by his book, and then give practical rules for the calculation of the proportions of the parts of the machines and the work which they would do. The general defect of the book is that the explanations of both the principles of operation and the details of construction are not full enough. More elaboration in both the illustrations and descriptions would have increased the value and usefulness of the book. Notwithstanding this defect, the reader will find—what is not common in books—that the information which he gains by reading its pages bears a very large proportion to the ground which he goes over—in other words, there is much grain and little chaff, and to get at the kernels there are no hard nuts given him to crack nor scientific and technical conundrums given him to guess, but all is made so plain that the book is almost as easy to read as a newspaper. It is brimful of interesting and useful information, which often comes to the reader in the form of a surprise. It would be interesting to know how many of the readers of this review could tell or know what the peculiarities of a Poncelet water wheel are. These are explained in a very few pages, so that the reader is never likely to forget them. The peculiarities of construction of Pelton water wheels are also described, and that there are single, double and multiple-nozzle wheels, and that with this wheel wide variations of power can be produced without essentially impairing the efficiency. This is done, first, by changing the size of the nozzle which delivers the water to the wheel; second, by a deflecting nozzle, by means of which the direction of the stream is varied; and third, by contracting or enlarging the orifice by which water is delivered to the wheel. Few American readers probably have any idea of the extent to which water-pressure engines are used in Europe, and the variety of the forms of construction which are employed, and which are described and illustrated in the book before us. The same remarks will apply to hydraulic rams. We confess that we never knew before that there are "pumping rams" which are actuated by dirty water, and raise clear water or any other liquid, fluid or semi-fluid. A number of these are illustrated and described, and apparently are in common use where the book was written. It contains over 200

engravings and an excellent index. Altogether, it is one of the kind of books which it is a pleasure and a profit to read.

TRADE CATALOGUES.

Modern Turret Lathe Practice. Published by the Gisholt Machine Company, Madison, Wis., U. S. A. 20 pp., 7¼ × 10½ in.

This is one of the monthly publications of this company, illustrating the machines which they are making and the work which can be done on them. There are some slight indications of editorial exhaustion in this number, but, like all its predecessors, it is interesting and instructive.

Hyatt Roller Bearing Company. Powell & Colne, 107 Liberty Street, New York. 12 pp., 5¾ × 9 in.

This pamphlet describes the Hyatt roller bearing, which consists of a single ribbon of steel wound on a mandril to form a close spiral. This forms an elastic roller which, it is claimed, adapts itself perfectly to the inequalities of the axle or the bearing, and cannot be crushed or distorted by side strains on the bearing or bending strains on the journal. Various applications of this form of bearing are illustrated and described.

Heaters. L. Schutte & Co., Engineers and Machinists, Philadelphia. 8 pp., 3¾ × 6 in.

This little pamphlet gives a description of an appliance for the noiseless heating of water by direct steam. The apparatus is briefly described as follows : "It consists of an outward and upward discharging steam nozzle covered by a shield which has numerous openings for the admission of water, so that the jet takes the form of an inverted cone, discharging upward. Air, admitted through a small pipe, is drawn in by the jet, and, by mixing with the steam, prevents the sudden collapse of bubbles and the consequent noise which is such a great objection to heating by direct steam in the old way. A valve or cock on this air pipe regulates the quantity of air as may appear most desirable.

Block Signaling and Interlocking. A Letter to the American Railway Association. By George Westinghouse, Jr. 14 pp., 7½ × 11 in., with large folded plate.

Automatic Block Signaling. The Union Switch & Signal Company, Pittsburgh, Pa. 12 pp., 7½ × 11 in., with 7 folded plates.

The first of these publications is a brief but clear description of the automatic pneumatic system of block signals and interlocking apparatus which has been developed by Mr. Westinghouse, and is now manufactured by the Union Switch & Signal Company. Without going minutely or fully into details, it describes the general principles and features of this block system so as to give a very good idea of the purposes for which it is intended and its method of operation.

The second pamphlet goes more fully into the general arrangement and application of such signals, and their operation is explained very clearly by a series of diagrams showing plans of tracks with signals and trains in the various positions which they would occupy when in operation.

Notice of a suit brought against the Hall Signal Company for infringement of patents and a list of these patents is also given. To a person wanting to get a general idea of the principles and operation of block signals without going into the details of their construction there is no publication that would be so serviceable to that end as the pamphlet before us.

Compound Locomotive. Built by the Richmond Locomotive & Machine Works, Richmond, Va. 28 pp., 6¾ × 10¼ in.

The publishers of this pamphlet give, first, a very good half-tone engraving of their works, with a brief description of them. Following this is a general announcement that they are prepared to build compound engines. After this are sectional views of the intercepting valve which is used, with a description of its construction and operation. Engravings follow of a simple and a compound ten-wheeled engine built by the company for the Chesapeake & Ohio Railroad, with tabular statement of dimensions, weight, etc. Another table gives the performance of 10 simple engines and one compound for a year. Indicator diagrams taken from the compound engine are also given.

Similar illustrations and descriptions of a simple and compound engine for the Cleveland, Cincinnati, Chicago & St. Louis Railway are also published, with reports of their performance. The significant figures are on the fuel consumption. On the Chesapeake & Ohio Road the simple engines ran on an average 15.22 miles to a ton of coal, and the compounds 20.46 miles, so that the compound engine did over a third more work than the simple engine with the same coal. On the Cleveland, Cincinnati, Chicago & St. Louis Road the simple engines burned 5.29 lbs. of coal per car per mile, while the compound engine burned only 3.52 lbs. This represents an economy of over 27 per cent. for the compound engine. If this rate can be maintained it must end the compound controversy, at any rate, so far as freight engines are concerned.

Another notable fact is the small difference in weight between the simple and the compounds, which in both cases is given at only 400 lbs. It would be interesting to know whether the weights given are actual weights taken from scales or "estimated." The evenness of the figures, 118,000 lbs. and 118,400 lbs. in the one case, and 135,600 lbs. and 136,000 lbs. in the other, indicates an "estimate," and not actual weights. The attitude of the writer on the subject is that of a compound *agnostic*. Perhaps from such a source—in the hope of his conversion—a little analysis and criticism may be tolerated. If the data from the Chesapeake & Ohio Road are reduced to pounds of coal consumed per car per mile, it will be found that the average consumption of 10 simple engines was 3.36 lbs. per car per mile, and that of one compound locomotive was 2.43 lbs., showing a saving of over 27 per cent. for the compound. If we take the best performance of the simple engines—that of No. 125—it will be found that it burned only 2.7 lbs. of coal per car per mile, so that, compared with it, the compound showed a saving of only 10 per cent. If, now, we make a comparison between the performance of the simple engines Nos. 108 and 125, we find that the first burned 3.93 lbs. of coal, and No. 125, 2.7 lbs. per car per mile, or a difference of 31.3 per cent.—that is, there is a difference of 31.3 per cent. between the best and the worst performance of the simple engines, and only 10 per cent. between that of the best simple engine and the compound. Now, if the smoke-stack of engine No. 125 had been painted red, by the same process of reasoning, the data before us would prove a resulting economy of 31.3 per cent. from the use of chimneys of that particular hue. All that is contended for here is that it would be fallacious, to infer from the data before us, that because the average fuel consumption of ten simple engines is 3.36 lbs. per car per mile, and that of one compound is only 2.43 lbs., that, therefore, there is a saving indicated by the difference due to the compound system. Ten compound engines working under the same conditions as the simple engines would probably show very different average results.

On the Cleveland, Cincinnati, Chicago & St. Louis Road 16 simple engines burned an average of 5.29 lbs. of coal per car per mile, while one compound burned only 3.52 lbs., which is apparently equal to an economy of over 33 per cent. Comparing the compound with the best performances of simple engines, the figures are 4.79 lbs. and 3.52 lbs., or a difference of over 26 per cent. in favor of the compound. The difference between the best and the worst performance of the simple engines is nearly 25 per cent. The point to which attention is especially called is that the reports before us show that there is as much difference in the economy of fuel consumption between different simple engines as there is between some simple and the compounds, and that the economy due to the compound system is much less than the data from the two roads referred to might indicate. We have no doubt of the fact that compound locomotives, under favorable conditions, will show some saving of fuel ; but that is no reason for entertaining the belief that the saving is much more than it really is.

Accompanying their interesting publication, the Richmond Locomotive & Machine Works have issued several leaflets giving the opinions of compound locomotives which were expressed by various persons at the recent convention of the Master Mechanics' Association. At that meeting there were great differences of opinion expressed, and apparently we have not yet reached the clarifying period in the discussion when there will be abundant facts to reason from and true values will be assigned to them. In the mean while, all reports agree in this, that the Richmond Locomotive & Machine Works are building some excellent simple as well as compound locomotives, some of which are illustrated in the publication before us, the design of which can be highly commended and the performance of which is indicated by the data given in their pamphlet.

BOOKS RECEIVED.

Engineering Construction in Iron, Steel and Timber. By William Henry Warren. London and New York : Longmans, Green & Co. 372 pp., 8 folded plates.

A TEXT-BOOK ON ROOFS AND BRIDGES, *Part III, Bridge Design.* By Mansfield Merriman and Henry S. Jacoby. New York: John Wiley & Sons. 425 pp., $5\frac{3}{4} \times 9$ in., 18 folded plates.

STRESSES IN GIRDER AND ROOF TRUSSES, *for both Dead and Live Loads, by Simple Multiplication.* By F. R. Johnson, Assoc. M. Inst. C E. New York: Spon & Chamberlain. 216 pp., $4\frac{3}{4} \times 7\frac{1}{4}$ in.

THEORY AND CONSTRUCTION OF A RATIONAL HEAT MOTOR. By Rudolf Diesel. Translated from the German by Bryan Donkin, M. Inst. C.E. New York: Spon & Chamberlain. 85 pp., $5\frac{1}{2} \times 8\frac{1}{2}$ in., with three folded plates.

NOTES AND NEWS.

Large Steel Plate.—It is claimed that the largest steel plate ever rolled was turned out by the Wellman Iron & Steel Works, at Chester, Pa. The dimensions of the plate are 450 in. long by 130 in. wide and $1\frac{1}{4}$ in. thick. It is intended as a rudder plate for one of the vessels now being built by the Cramps for the International Navigation Company. The rudder plates called for were so large that there were only two mills in the world having sufficient capacity to make them—one at Krupp's and the other at Wellman's.

Ship Railway on the Columbia River.—An appropriation of $150,000 has been made by Congress for the preliminary work on a ship railway to be constructed through the Dalles, on the Columbia River, in Oregon. The car that will be used will be 40 or 50 ft. in breadth, and long enough to carry vessels that can steam up the river, which in the spring months, when the water is high, will allow a draft of about 14 ft. The car will be sunk under water and the vessel floated over it; the car will then be raised by a hydraulic lift some 70 ft. above the water level to the height of the land track and the car run upon it. This land track will consist of four or five railway tracks of standard gauges, and there will be no curves sharper than 2°.

The New Torpedo Boats.—The chiefs of ordnance construction and steam engineering of the Navy have completed their design for the three new torpedo boats authorized by Congress, and it is likely that advertisements for proposals will be invited in the course of a month. The vessels will be slightly larger than the *Ericsson*, and will show several novel features, the chief of which consists in placing the propellers abaft the rudder, this experiment having been tried with success abroad. As compared with the *Ericsson*, the dimensions of the new vessels are as follows:

	New.	Ericsson.
Length load water line	160	150 ft.
Beam " " "	16	15.05
Draft " " "	5	4.75
Displacement	135 tons.	120
Indicated H.P.	2,000	1,800
Speed in knots	24.5	24
Coal capacity (tons)	50	40

A decided innovation consists in placing the quarters for officers forward and those of the men aft, which is a return of the method Ericsson pursued in designing the monitors, having particularly in mind the comfort of the enlisted men. The officers' quarters will be more roomy than those on any other torpedo boat as a result of putting the tubes above deck, while the accommodations for the men are unusually large, due to the extension of the broad water-line aft to prevent excessive squatting so noticeable in high-speed vessels. The contract price of the *Ericsson* was $113,500 for hull and machinery alone. The new vessels are limited in price to $150,000 each, including torpedo equipment and full outfit. Under the law no premiums will be paid for extra speed, but on account of the increased H.P. and finer lines of the new vessels there is little doubt that they will make 24.5 knots, which must be guaranteed by the contractor. With the exception possibly of the submarine boat, these three are the only vessels which will be commenced by the navy during the current year.

Mechanical Traction of Paris Street Cars.—Compressed air on the Mekarski system has for some time been used to drive street cars in Paris, and has been adopted on three of the lines operated by the General Omnibus Company. The longest of these is about 12 miles, and the three aggregate 24 miles. Trains of three cars, seating 51 persons each, are to start from the Louvre at quarter-hour intervals, and at a junction point are divided, one car going to St. Cloud and the other two to Sèvres and Versailles. The locomotives drawing these trains are carried on six-coupled wheels. They will weigh 18 tons, and have to surmount an incline of 1 in 23 on a part of the line. Twenty-three locomotives are to be built to operate these lines, six being kept in reserve. The air pressure carried in the reservoirs will be 1,138 lbs. per square inch, and a sufficient quantity of air will be carried to enable the locomotives to run 12 miles without recharging. The Northern Tramways Company of the same city has adopted electric accumulators for the operation of its cars. These are arranged to seat 52 persons and run at a speed of $7\frac{1}{2}$ miles inside the city and 10 miles an hour outside the barriers. The maximum grades are 4 per cent., and each car runs about 80 miles a day. The motive power is supplied by a battery of 108 cells, having 11 plates each. These cells are fitted inside 12 cases. They are coupled in four groups of 27 cells each, so that the electro-motive force of each group is about 50 volts; and as these groups may be arranged either in series or parallel, a wide range of potential is at the service of the driver. The two motors which drive the axles may also be coupled at will in series or parallel, so that a reserve of power is available for climbing grades. The total weight of the car with accumulators and passengers on board is 12 tons. Readings on a complete run showed that the average tractive effort was about $15\frac{1}{2}$ to 17 lbs. per ton, but the maximum was 80 lbs. per ton. The cost is almost the same as horse power on the same lines.

A New Russian Battleship.—On June 2 last there was launched from the yard of the New Admiralty, St. Petersburg, Russia, the great armored battleship *Sisoi the Great* (*Sisoi-Veliki*). The Emperor, the higher officers of the fleet, army and civil administration, and the whole diplomatic corps were present at the ceremony. This ship is the first of four armored ships which were laid down by the Emperor in May, 1892. The hull is constructed of steel made by the Tjora Admiralty Works in Kolpino (near St. Petersburg). It is designed on the lattice-work system, with double bottoms. The strength and security of the hull is insured by means of longitudinal and transverse bulkheads, which divide the whole space into 21 water-tight compartments. The principal dimensions of the ship are as follows: Length between perpendiculars, 332 ft.; length on loaded water-line, 345 ft.; length over all, 351 ft. 10 in.; breadth, 68 ft.; draft from 22 to 23 ft.; full displacement, 8,880 tons. The sides are vertical, being 18 ft. forward and 17 ft. aft. The fore run is straight, and provided with a cast-steel ram fastened by horizontal brackets. The after run extends vertically into the water, and at the depth of from 6 to 8 ft. it is cut away so as to form a space for the rudder and screws, which are fully protected. The rudder is of the ordinary type. The deck armor protection consists of a turtle-back deck, 3 in. thick, sloping off at the bow and stern and along the sides of the vessel. The crown of the deck at the center of the ship is 3 ft. above the water-line, while the inclination all round comes down to the sides at a point 5 ft. below the water-line. All the vital parts of the ship, such as engines, boilers, steering gear and magazines are placed beneath this deck, while immediately above it is the lower armored redoubt, 250 ft. long. The thickness of the armored plates is 16 in. The second redoubt is 60 ft. shorter. The third and upper redoubt is still shorter, and contains the additional armament of the ship. The space between the extremities of redoubts is covered with armored decks, and on the extremities of the lower redoubt armored towers are placed. These towers carry the gun turrets and establish communication with the inner rooms, magazines and stores. The diameter of the turrets is 30 ft.; height, 10 ft., and the thickness of armor plates 16 in. Each turret contains two 12-in. Oboukov guns, 40 calibers long. The height of the trunnions above the water-line is 23 ft. In addition to this armament the ship carries six 6-in. rifled guns and 18 Hotchkiss quick-firing guns. The 6-in. guns and the four of Hotchkiss guns are placed in the covered battery; the other quick-firing guns are on deck. The torpedo armament consists of six launching apparatus for Whitehead torpedoes, two torpedo-boats, and a stock of spheroconic torpedo catchers; besides these it has Boliven nets and Mangen electric projectors, in order to guard against submarine assault. Electric lighting will be used throughout the ship. The main engines are triple expansion, and consist of two independent engines of 8,500 I.H.P. There are 12 boilers of the Belleville water type with three fire boxes. The greatest speed of the ship is 16 knots. The bunkers will carry 550 tons of coal, sufficient for a voyage of 5,000 miles at a speed of 10 knots. The engines and boilers were built by the Baltic Works.

The quarters for crew and officers are very comfortable. They are high, spacious, well ventilated and lighted, because they are well up over the water-line and are provided with numerous port holes. The quarters for the crew and a portion of the officers are on the lower deck, while those for the

captain and the admiral are located astern on the upper battery deck. From the admiral's cabin a door leads to a gangway running entirely around the stern. The ship is being built by the New Government Admiralty under the superintendence of Maksinoff, as engineer, and Colonel Propoff. The whole cost will be $4,250,000. The construction was begun in 1891.

To Newark by Trolley.—A correspondent describes, in the New York *Sun*, how he went to Newark by a trolley car:

"I bought passage," he says, "at a little ticket office which stands on the sidewalk in Cortlandt Street against the side of the building on the southeast corner of West Street. For 10 cents I received two tickets, one entitling me to a ride over the ferry and the other to a ride on the electric cars from Jersey City to Newark.

"We left New York at 2.31 P.M. We started from Jersey City at 2.42 in a large open car in which there were 26 passengers. It is a familiar fact that these cars take only through passengers, but passengers are taken up by outgoing cars anywhere on the line in either terminal city, to be set down anywhere on the line in the other. . . . This car arrived at the Market Street Station of the Pennsylvania Railroad at 3.24. Time from New York, 53 minutes; time from Jersey City, 42 minutes. Time on the Pennsylvania Railroad by a train scheduled to leave New York at 2.30 from New York to Market Street, 36 minutes; from Jersey City, 21 minutes. There are trains that make the distance in less time. I stayed on the car to Broad Street and got off there, that being the point nearest where I wanted to go. Arrived at Broad Street at 3.27. Time from Jersey City, 45 minutes; distance from Jersey City about 8¼ miles. So that the actual speed of the car was at the rate of about 12 miles an hour."

Delaware & Hudson Shop Tools.—Among the handy shop tools which we have illustrated from time to time as having been designed and constructed in the shops of the Delaware & Hudson Canal Company, we show three which are especially convenient. Fig. 1 is a gauge for measuring distances between the insides of wheel flanges. The plunger at the left-hand side bears up against the spring and carries the index along the scale shown, which marks the distances between the two ends at any time. This is a very rapid and quick method of determining whether wheels have been pressed to the proper gauge or not. Fig. 2 is a handy holder for holding a reamer or tap in a drill press. The chuck is fitted into the chuck socket of the spindle and bored out straight to take the tap holder. On one side there is a slot through which a pin in the tap holder moves, allowing a certain amount of vertical motion, so that as long as the pin is kept clear from the top and bottom of the slot there will be no tendency to cramp or pull out the socket. The tap is provided with a taper shank and is held in position by a set screw shown by dotted lines. Figs. 3 and 4 are side and front elevations of a handy little truck used for moving hydraulic jacks about the shops. As these jacks are too heavy for one man to carry, and as rolling them over the floor is a slow process, it is evident that considerable time will be saved by having a light truck on which they can be loaded and moved from one point to another as rapidly as the ordinary laborer would walk, which, at the best, is not too fast. This truck consists of a piece of iron bent to the shape shown in fig. 3 and cut out as shown in fig. 4. It has a bracket riveted to it for carrying the upper end of the jack, while the lower end is riveted to an axle carried by two smaller wheels which just touch the floor when the truck is in position, shown in fig. 3.

FIG. 1.

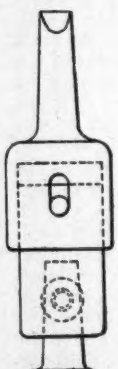


FIG. 2.

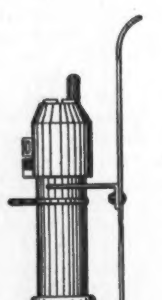


FIG. 3.

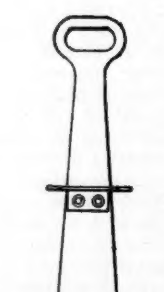


FIG. 4.

The Warships of China and Japan.—Since the outbreak of war between China and Japan, some particulars about the natures and relative strengths of their fleets will doubtless be of interest to some. The Chinese fleet includes 5 armored ships and 24 unarmored vessels, in addition to 24 small gun-boats and 6 floating batteries.

NAME OF IRONCLADS.		H. P.	ARMOR.		Date.	Speed.
			Belt.	Turret or Barbette.		
	Tons.		In.	In.		Knots.
Chen-Yuen	7,430	6,200	14 co.	12 co.	1882	14.5
King-Yuen	2,850	3,600	9½	8 "	1887	16.5
Ping-Yuen	2,850	2,400	8	5	1890	10.5
Lai-Yuen	2,850	3,600	9½	8 co.	1887	16.5
Ting-Yuen	7,430	6,200	14 co.	12 "	1881	14.5

The *Chen-Yuen* and the *Ting-Yuen* are of fair size, the others being small, and one of them, the *Ping-Yuen*, comparatively slow. They are well armed; the *Chen-Yuen* and *Ting-Yuen* have 12-in. Krupp guns, the *King-Yuen* has 8-in. and the *Ping-Yuen* 10-in. guns, besides smaller ones. Among the unarmored ships the *Chih-Yuen* and the *Ching-Yuen* are the most formidable, being of 2,300 tons displacement, 5,500 H.P. and 18 knots speed. They have 10-in. steel barbettes and three 8-in. 12-ton guns each, besides quick-firing and machine guns. The *Tshao-Yong* is a vessel of 1,350 tons displacement, 2,677 H.P. and 16.8 knots speed. She was launched in 1881, and armed with two 10-in. Armstrong guns, four 4.7-in. quick firers, and 7 machine guns. The armored ships of Japan are not formidable as ironclads. They are as follows:

NAME.		H. P.	ARMOR.		Date.	Speed.
			Belt.	Battery.		
	Tons.		In.	In.		Knots.
Fu-Soo	3,718	3,500	7	9	1877	13.2
Hi-Yei	2,200	2,490	4½	..	1878	13.0
Kon-Go	2,200	2,450	4½	..	1877	13.7
Rio-Jo	1,459	975	4½	4	1864	9.0
Tschiyoda	2,450	5,600	4½	..	1889	19.0

The last of these would be better described as a protected cruiser than an iron-clad. The others are small, weak and slow. There are 32 unarmored ships, of which the *Akitsuschima*, the *Hasidate*, the *Itsukushima*, the *Metsuchima* and the *Yoshino* are the most formidable. The latter is one of the most rapid cruisers afloat, having 15,000 H.P. and 23 knots speed. All these vessels have been launched since 1891, and if they come into conflict we shall be able to judge of the relative merits of armor and no armor. The Japanese cruisers are more numerous and larger than the Chinese, and many of them are model craft in the eyes of those who believe that armored protection is not worth what it costs.—*Invention.*

A Defect in Engineering Education.—In his address before the Mechanical Section of the British Association, Professor Kennedy, the President of that Section, made the following very sensible observations with reference to one branch of the education of engineers, which it is thought is very much neglected in this country as well as in Europe. In referring to it, the professor said:

"It is not easy to overrate the importance to the engineer, as to other folk, of the power of saying clearly what he means, and of saying just what he means. I do not mean only of doing this for its own sake, but because if a man cannot say or write clearly what he means it is improbable that he can *think* clearly. By the power of expression I do not mean, of course, the mere power of speaking fluently in public—a thing which appears physically impossible to some people; I mean, rather, the power of expression in writing, which carries with it clearness and consecutiveness of thought. It is difficult to know how this matter can be taught, but at least it can be insisted upon probably to a much greater extent than is commonly the case. A man requires to see clearly not only the exact thing which he wants to say, but the whole environment of that

thing as it appears to him. Not only this, but he must see the whole environment of the same thing as it appears to the persons for whom he is writing, or to whom he is speaking. He has to see what they know about the matter, what they think, and what they think they know; and if he wishes to be really understood has got to do much more than merely write the thing he means. He has carefully to unwrite, if I may use the expression, the various things that other people will be certain to think that he means. For, after all, the great majority of people are very careless listeners and readers, and it is not for the small minority who are really exact in these matters that one has to write."

A New Elementary Body Discovered in the Atmosphere.—In describing the recent Proceedings of the British Association, a correspondent of *Nature* says:

"So far as the scientific importance of the communications made to the present meeting is concerned, it is conceded on all hands that a verbal and really an informal announcement made by Lord Rayleigh to Section B, on Monday, on behalf of himself and Professor Ramsay, takes the first place. It is known that Lord Rayleigh has been for many years engaged upon the determination of the densities of various gases. We have learned that he found in the case of nitrogen different densities amounting to about ½ per cent., according as the gas was obtained from chemical compounds and the so-called nitrogen of the atmosphere. This and other points have recently occupied the attention of both Lord Rayleigh and Professor Ramsay, and they have succeeded in isolating from this so-called atmospheric nitrogen, and by two distinct processes, a second inert ingredient denser than true nitrogen. The first method employed was that used by Cavendish in his demonstration of the composition of nitric acid. Air mixed with oxygen is submitted to electric sparks in presence of alkali until no further contraction takes place. The excess of oxygen is then absorbed by pyrogallol. That the residual gas is not nitrogen is inferred from the manner of preparation, and from the appearance of its spectrum. A second method giving much larger quantities of the new gas depends upon the removal of nitrogen from deoxygenated air by passing it over heated magnesium. When this process was allowed to continue, the density gradually rose to 14.88, 16.1, and finally to 19.09. At this stage the absorption appeared to have reached its limit, indicating that the new gas amounts to about 1 per cent. of the nitrogen of the atmosphere. When the gas thus prepared was sparked with oxygen there was little or no contraction. Lord Rayleigh and Professor Ramsay have already found that no liquefaction occurs when the gas is compressed at atmospheric temperatures.

"Sir Henry Roscoe said that the communication was one of the greatest possible interest and importance, and the Section as well as the distinguished authors were greatly to be congratulated on the announcement of the discovery of what would in all probability turn out to be a new elementary body existing in the atmosphere. The discovery appeared to him to be of special significance, as being one brought about by the application of exact quantitative experiment to the elucidation of the problem of the chemical constitution of our planet."

Pumping Air into the Earth.—What is known as the Heckert-Rowland plan for generating natural gas in the bowels of the earth is about to be given a practical demonstration in Findlay, O. The necessary pumps and engines are now being erected on the site of the old Wetherald rolling mills, in the northeastern part of the city. This is in the vicinity of several abandoned gas wells which will be utilized for conducting the experiments. The theory, which was evolved by William Heckert, a well-known mechanical engineer, at present a member of the Findlay City Council, will work a revolution in the natural gas region if it proves practical.

Heckert proposes, by means of powerful pumps, to force air down into the gas-bearing rocks, which it will permeate, and thereby become infused with the active properties of the gas itself. It is contended that as now burned for fuel, the natural gas requires an admixture of nine parts of air to one part of gas, and that this mixing can as well be done in the earth as in the stove or in the furnace where it is burned. The great trouble in the gas region is not so much the decrease in the volume of gas as the decrease in the pressure. This has fallen off in a large portion of the Ohio field, from 400 lbs., at which it started, to 40 to 80 lbs., and this is found to be insufficient to convey the gas from the wells through the system of pipes to the point of consumption. The friction takes up all the initial pressure.

By Heckert's process this lost pressure will be re-established. His air pumps, constantly at work, will force enough air down one hole to create a pressure sufficient to force the remaining gas, mixed with the air, out of several other holes, and give it a strong initial pressure in the pipes. The gas thus formed or charged with air will be ready for burning with little additional mixture of air at the point of combustion. It is also claimed by Heckert that air thus pumped down into the rock and passing over and through the pools of oil which are now almost universal in the Trenton rock in this section will take up the volatile gas of the oil and force it up the convenient wells ready for use.

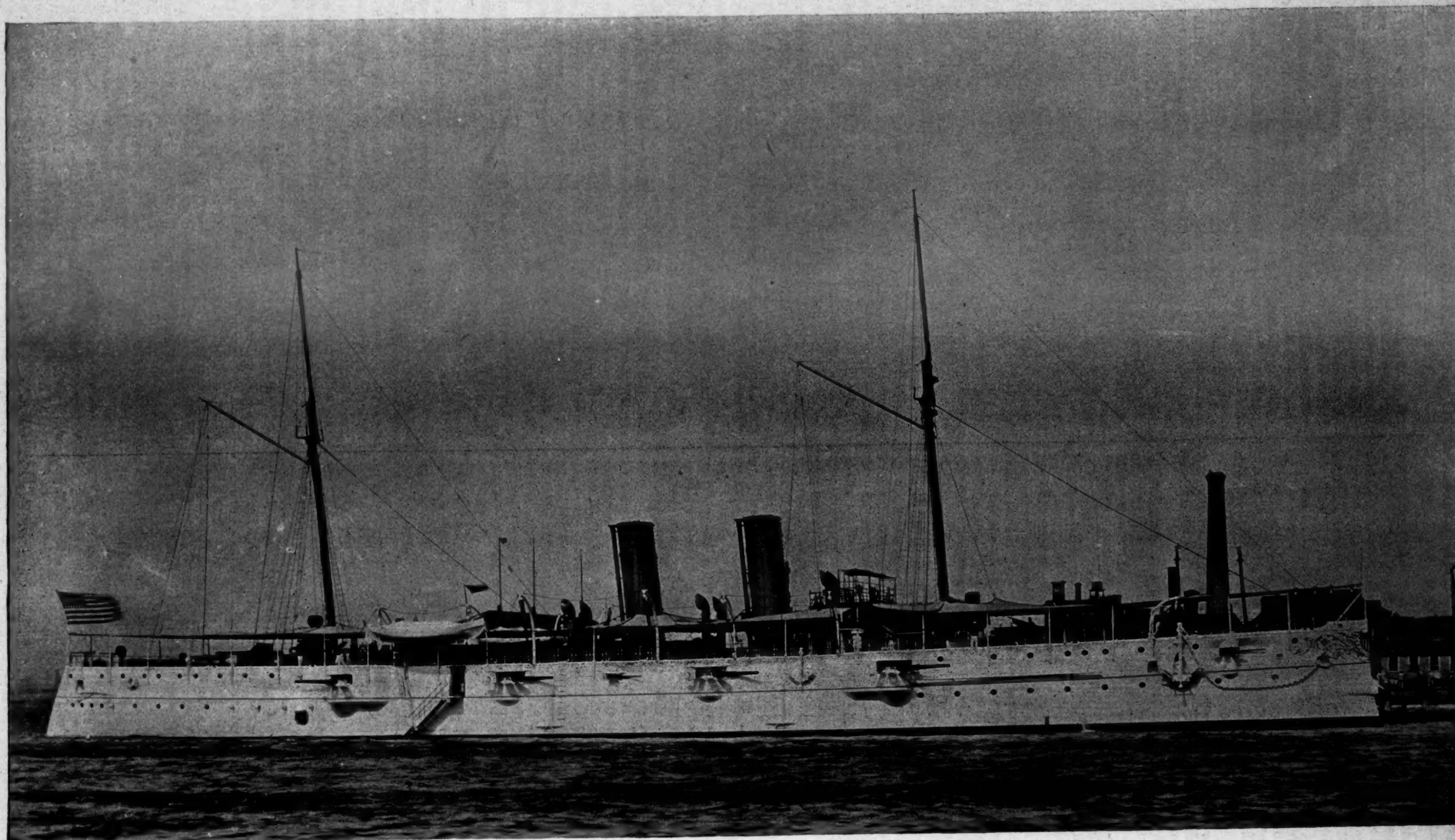
Inside of a month or two the preparations for the trial of this important theory will be made.

Electricity in Workshops.—A paper on this subject was read at the recent meeting of the Iron and Steel Institute, in England, by Mr. Selby Bigge, in which the author gave some interesting particulars of the progress that has been made in Belgium in using electricity as a means of distributing power in factories and workshops. The question has become one of commercial expediency, and the author boldly attacks it from this point of view, stating that his "whole contention in advocating electricity as the right and proper agent of operating new works, and as a means whereby old works can be remodeled, may be summarized by the one word 'economy.'" As an instance in point, he quoted the National Arms Factory at Herstal, near Liège. These works were recently founded to execute, in the first instance, an order for 200,000 rifles, the production being guaranteed at 250 rifles every 12 working hours. The Compagnie Internationale d'Electricité supplied the electric power installation, laying down 13 motors, ranging between 16 H.P. and 37 H.P., and giving a total of 260 H.P. For the former size of motors they guaranteed a commercial efficiency of 87 per cent., and for the latter 89 per cent. The total power of the motors (260 H.P.) would therefore be obtained by 296.9 initial H.P. There was a large amount of electric lighting to be done also, so that an engine and dynamo of 500 H.P. was installed. The ratio between the electric energy available and the energy transmitted to the shaft by the engine was guaranteed to be 90 per cent. The electric motors drive the line shafting of the machines, and the efficiency of transmission—that is to say, the ratio between the power available and the effective H.P. developed by the steam engine—is given by the product of three efficiencies, as follows: 90 per cent. for the dynamo, 98 per cent. for the conductors and 87 per cent. for the motors = 76.6 per cent. The installation has now been running for three years without being the cause of cessation of work for a single minute.

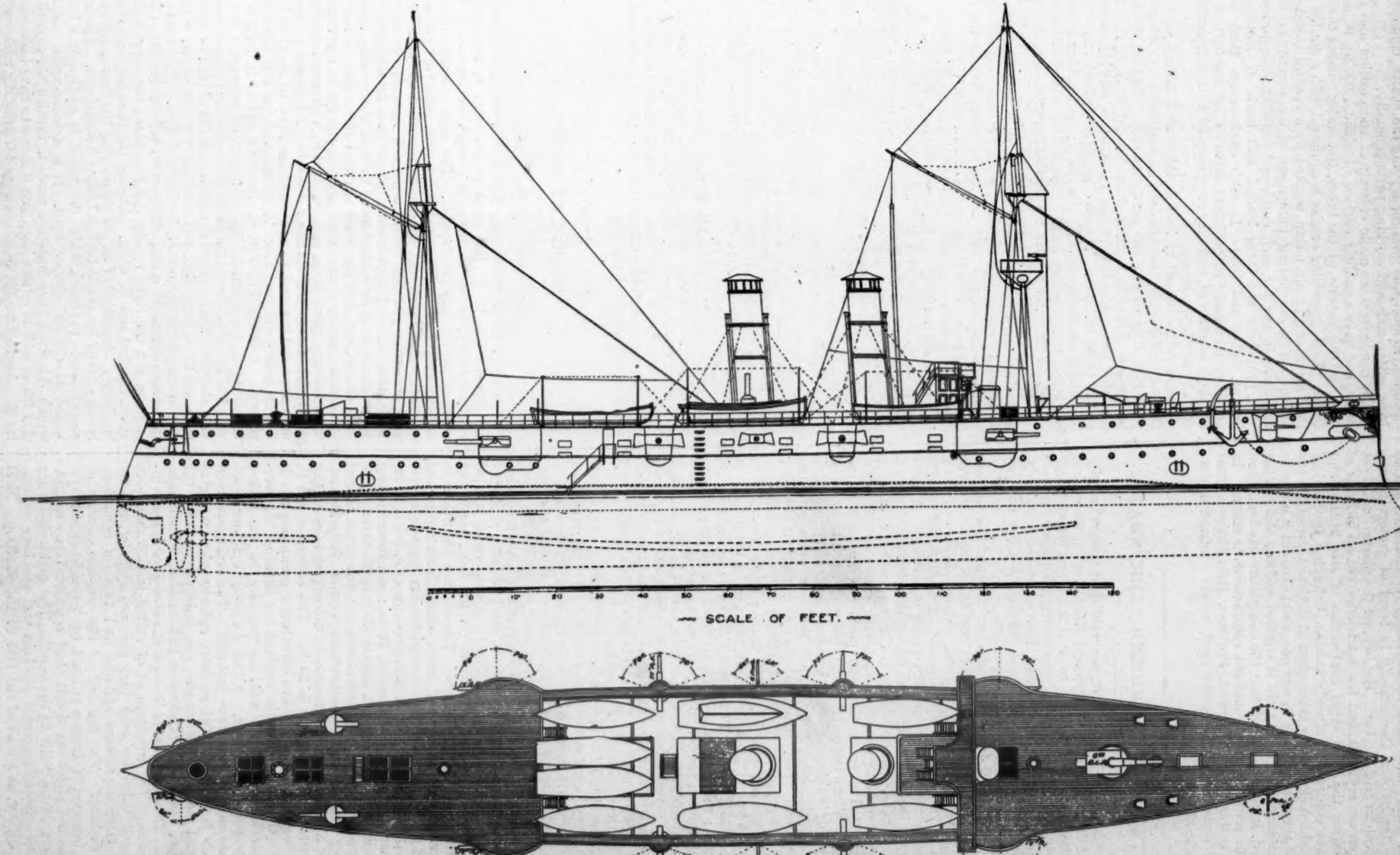
It is a very difficult matter to form comparisons between the respective efficiencies of different methods of power distribution, and it may be pointed out that in the Herstal case the electric system does not appear to its greatest advantage, as the motors drive line shafting in place of being attached directly to the machines. There is no doubt, however, that a very strong case can be made out for electricity, and electrical engineers may look forward with confidence to a large extension of their field of activity in regard to power distribution.—*Nature.*

The Extensibility of Iron and Steel.—At the recent meeting of the British Association, Professor Fidler read a monograph on this subject, of which the following abstract appeared in *Nature:*

"The author pointed out that the stress-strain diagram of ductile material as autographically drawn does not indicate any definite relation between tensile stress and plastic strain. The unit stress varies in different parts of the bar; the elongation measure by the diagram being that of the whole bar. The author's experiments indicated that the plastic extensibility under any given stress is nearly the same in all segments of the bar's length, even when the ultimate elongation varies. Volumetric measurements of the successive segments indicate that there is no sensible telescopic shear, and justify the general application of the assumption of unchanging volume. It might at first sight be supposed that a bar of uniform plastic extensibility ought to draw out uniformly over its whole length, but beyond a certain critical point a uniform extension is almost impossible. In order to illustrate these points in a bar of mild steel a diagram had been prepared. The law of plastic extension is determined by the curve, fixed mathematically the curves of the plastic limit, and it fixed also the breaking weight per square inch of original area. In regard to the possibilities of deformation in a bar of nearly uniform extensibility, as the plastic limit is approached the slightest irregularity in section or in extensibility tends to precipitate the formation of a contracted region, and beyond that limit the further extension of the bar and the further contraction of area will be confined to the same region. For stresses below the plastic limit the probabilities of deformation might be examined by considering the relative time rates of extension at two



UNITED STATES CRUISER "CINCINNATI," BUILT AT THE BROOKLYN (N. Y.) NAVY YARD.



ELEVATION AND DECK PLAN OF THE UNITED STATES CRUISER "CINCINNATI."

elements which may have been unequally stretched, and at first the tendency is theoretically in favor of preserving the cylindrical form of the bar. But beyond the plastic limit these conditions are reversed, and the tendencies are all in favor of precipitating the most rapid contraction of area at the point where any contraction already exists. Referring to the yield point, sudden elongation takes place at different stresses in the different segments, while in any one short element it seems to be instantaneous. If the yield is arrested midway and the bar examined, it may be found that the elongation has been completed in some segments and not commenced in others. In the discussion which followed, Professor Hele-Shaw pointed out that certain bronzes, unlike steel, would contract in several places at once."

UNITED STATES CRUISER "CINCINNATI."

In our issue for March, 1890, we published a short description and illustration of the cruisers Nos. 7 and 8, which had at that time just been ordered built at the Brooklyn and Norfolk Navy Yards respectively. Since that time work on these vessels has been completed, and No. 7, which was christened the *Cincinnati*, is now in commission, and has had her trial trip before the Board of Inspection.

On pages 442 and 443 we publish a half-tone and line engraving showing the appearance of the vessel as she lay at the cob dock at the Brooklyn Navy Yard, and her lines and deck plan. The vessel has a displacement of about 3,000 tons, is propelled by twin screws, and her speed is 19 knots. A complete protective deck 2½ in. thick on the slopes amidship and 2 in. on the slopes on the ends and 1 in. on the flat covers the vessel from stem to stern. Arrangements are made for storing patent fuel over the inclined parts and above it at the water-line. There is a coffer dam filled with woodite running along the ship's sides. She has a double bottom throughout, is provided with electric lights, and the ventilation is on the exhaust system. The capacity of the coal bunkers is 560 tons, and with this supply the radius of action at various speeds will be: At 20 knots per hour, 1,243 knots; at 18 knots, 2,213 knots; at 16 knots, 2,964 knots; at 14 knots, 4,190 knots; at 12 knots, 5,925 knots; at 10 knots, 8,652 knots; and at 8 knots, 9,982 knots; thus, at an average speed of 10 knots an hour, she can be kept at sea for 36 days without coaling.

The general dimensions of the ship are: Length, 300 ft.; beam, 42 ft.; displacement at a mean draft of 18 ft., 3,100 tons; the vessel is schooner rigged, and has a military top half way up each mast; the rudder is balanced and carries out the lines of the after-body of the ship.

The armament consists of one 6-in. breech-loading rifle mounted on the topgallant forecastle on a central pivot carriage; ten 5-in. rapid-fire guns mounted as follows: One on each side of the poop, and four for broadside fire on each side of the spar deck; the forward and aft guns on each broadside are sponsoned for bow and stern fire. The secondary battery consists of fourteen 6-pounder rapid-fire guns, six 1-pounder rapid-fire guns and four Gatlings. In addition to this the vessel is fitted with six torpedo-tubes, disposed one in the bow, one in the stern and two on each broadside. The engines are triple expansion, vertical, inverted, and direct acting, built rights and lefts, and placed in water-tight compartments separated by a fore-and-aft bulkhead. Each high-pressure cylinder is 36 in. in diameter; intermediate pressure, 23 in.; and there are two low-pressure cylinders for each engine 57-in. in diameter. The use of two low-pressure cylinders was not due to the fact of that being the approved construction by the Navy Department, but to the exigencies of space in the engine-room. The common stroke of all pistons is 33 in. The collective I.H.P. of propelling and air-pump and circulating-pump engines is about 10,000 when the main engines are making 164 revolutions per minute with a working pressure in the boilers of 160 lbs. per square inch. All of the lower cylinder heads of the main engines are steam jacketed. The arrangement of the engines is with the high-pressure cylinder of each engine forward and the low pressure aft; the main valves are of the piston type, worked by Stephenson link motion, with double-bar links. The piston valve liners and valve gear is made interchangeable. The arrangement of valves is such that there is one piston valve for each high-pressure cylinder, two for each intermediate-pressure cylinder and two for each low-pressure cylinder. The framing of the engines consists of cast-steel inverted Y frames trussed by wrought-steel stays. The engine bed plates are of cast steel supported on wrought-steel keelson plates built in the vessel. The crank-shafts are made in two interchangeable sections and one long section. They are hollow, as are all of the rest of the shafting. Mild open-hearth steel was used for forging the shafts, connecting-rods, piston-rods and working parts generally.

The condensers are made entirely of composition and sheet brass, and have a cooling surface of about 7,000 sq. ft. measured on the outside of the tubes, the water passing through them. Each propelling engine is equipped with a double vertical single-acting air pump worked by a vertical compound engine. The circulating pumps are of the centrifugal type, and there is one for each condenser working independently. The propellers are three bladed, and made of manganese bronze, rights and lefts. In each engine-room there is an auxiliary condenser of sufficient capacity for one-half of the auxiliary machinery, and they are provided with compound air and circulating pumps.

Steam is furnished by four double-ended boilers and two single-ended boilers, that are used as auxiliaries and which are placed in four water-tight compartments. Two of the main boilers are 13 ft. 4 in. outside diameter and 20 ft. 3½ in. long; the other two main boilers are 14 ft. 6¼ in. outside diameter and 20 ft. 3½ in. long. The two auxiliary boilers are 11 ft. 2 in. outside diameter and 9 ft. ½ in. long; the working pressure is 160 lbs. to the square inch. Each of the main boilers of 13 ft. 4 in. in diameter has six corrugated furnace flues, made by the Continental Iron Works of Brooklyn, N. Y. These furnaces have an internal diameter of 3 ft. 4 in.; each of the other main boilers has six corrugated furnace flues 3 ft. 8 in. internal diameter, and each of the auxiliary boilers has two furnaces with an internal diameter of 2 ft. 9 in.

Measuring on the outside of the tubes, the total heating surface amounts to 19,382 sq. ft., the grate area being 597 sq. ft., which gives a ratio of 1 to 32.5. The main feed pumps are located in each of the forward and aft fire-rooms, a smaller pump being supplied for each auxiliary boiler. Each of the feed pumps, furthermore, connects with a main feed pipe, and has a capacity sufficient to supply the four main boilers when steaming at full power.

The forced draft system in each fire-room consists of a blower which discharges into a main air duct under the fire-room floors, from which a branch duct leads to the ash-pit of each furnace. Means are provided for closing the ash-pits when under forced draft, and preventing leakage of gases out of the furnace doors; the draft for each furnace being regulated by means of dampers.

Among the auxiliary machinery there is the usual steam reversing gear, ash-hoist, turning engines, auxiliary pumps, engine-room ventilating fans, engines for driving, workshop machinery, distilling apparatus, and such other auxiliary and supplementary machinery, tools and instruments as are usually required for vessels of this class.

AMONG THE SHOPS.

THE HORNELLSVILLE SHOPS.

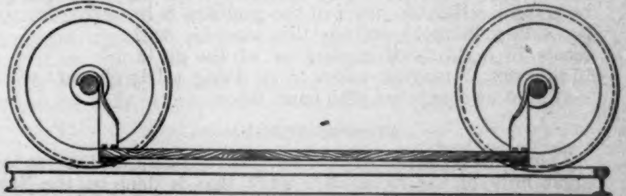
The shops of the New York, Lake Erie & Western Railroad, at Hornellsville, N. Y., like most of the other railroad shops of the country, are by no means at present turning out all the work of which they are capable. The main machine shop is an iron and brick building equipped with modern tools, and so arranged with storage space beneath the floors that, however well the pits for the repairing of locomotives may be filled, that litter of innumerable pieces that by some skillful legerdemain must be stowed away to form the working engine does not appear, and the shop has that clean and picked-up appearance that is always so pleasing to the eye of the visitor. This storage space is an excavation 8 ft. wide and 7 ft. deep, fitted with storage shelves along one side. At present all parts are raised and lowered to and from the floor by hand tackle, but air hoists will very soon be substituted for this laborious process. A drum 3 ft. 6 in. in diameter and 18 ft. long is to be placed at the center of the storage vault to act as a reservoir for the air lifts that will be located at convenient intervals along the floor. The usual arrangement of pits, of which there are 22, on one side, and machinery on the other, with a free space down the center, is followed here. The work of the shop consists in doing the general repairs for about 225 engines, and the light repairs and furnishing the supplies for about 150 that run in daily. Among the machine tools there is a handy adaptation of an old shaper that has been converted into a grinder for guide-bars and other flat surfaces. The carriage is made to travel, while the wheel is carried on a head bolted to the old shaper head. It is a home-made tool, in which the scrap heap has been made to furnish the material, that fits so well to its new uses that it seems to have been made for it. Another tool is an attachment for grinding rocker-arm

hubs, spade-handles, and similar parts that are more or less irregular. One of the special tools that has been built for this shop is a link-grinding machine, similar in all important respects to that illustrated in the AMERICAN ENGINEER AND RAILROAD JOURNAL for October, 1893, and which has been in use on this road for a dozen years or more. The company have abandoned the use of all steam packing or packing that is set out by springs in their pistons, and now use a hollow piston with two grooves cut in the external face into which cast-iron packing rings are sprung. This is not only very much cheaper and lighter than the old construction, but appears to be fully as effective against leaking. The rings are split and a piece cut out, the two ends being brought up against a pin set into the groove and flattened at the sides. This prevents the rings from turning, and breaks the joints of the split. It has not only given excellent results in practice, but has served to lessen the number of piston-ring breakages, for before the adoption of the solid head there was a great deal of trouble from this cause. While referring to the home-made tools, allusion must be made to the arrangement for grinding joints in stand, dry and steam pipes. It is nothing but an old drill press with a swinging frame added, by which the collar to be ground can be rotated and moved over the end of the pipe to which it is to fit. It has a universal motion, and does its work so easily and rapidly that it must divide the expense of making such joints by hand by from five to seven.

PLOW FOR CLEARING CINDER PITS, NEW YORK, LAKE ERIE AND WESTERN RAILROAD.

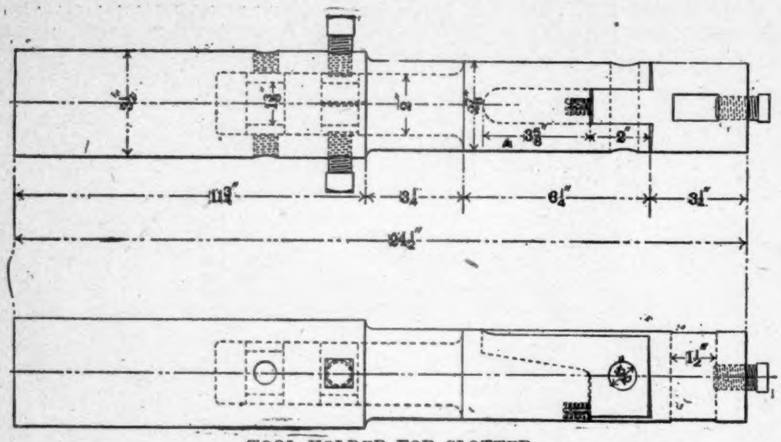
The value of the milling machine as a competitor of the planer is fully appreciated, and it is used on all work for which it is at all available. There are as yet no power hoists over the pits; but the work of raising those parts that cannot be located by hand into their proper positions is done by self-sustaining hoists hooked into diagonal slings swung at two or more points over the pits. At frequent intervals air pipes are led down beside the roof columns, with valves for making attachments to open furnaces that are used for heating rivets and work of a similar character.

Opening off the main machine shop is the paint shop, which has a tank or store closet that is worthy of imitation. It is purely for protection against fire and those persons who are prone to help themselves to the property of other people. It consists of a plate-iron room about 7 ft. high, 8 ft. wide and 12 ft. long. It is ventilated at the top, but the ventilator is so protected that it is impossible for maliciousness or carelessness to get fire into the place by that opening; and the entrance is closed by a plate-iron door that is locked at night. All paints and oils are stored in this vault at night, and the oil and varnish tanks are built in permanently, so that all danger from fire is removed.



The power house is equipped with six locomotive boilers, a Corliss engine with a 17 in. $\times$ 48 in. cylinder. This engine drives all of the machinery of the machine and wood-working shops. There is also a smaller slide-valve engine driving three 10-light dynamos.

Among the buildings connected with the shops is the oil house, which is provided with an air lift very similar to that illustrated in our issue for August, as in use by the West Shore Railroad, for forcing the oil from the barrels in which it is delivered to the storage tanks. The dope used for packing oil boxes is prepared here in a large tank, of which we give a sectional engraving. The waste is dumped into one of the compartments marked "soaking," and after being covered with oil is allowed to soak for a couple of weeks. It is then ready



TOOL HOLDER FOR SLOTTER.

for use, and a quantity is always kept in the draining screens for immediate delivery. In the bone yard there is a narrow gauge track of 2 ft. gauge running down between the two lines of cripple tracks. On this track there is used about the simplest type of railroad car with which we are familiar. It consists of two pairs of small wheels and axles upon which a plank is hung. It can be dismantled by one man and lifted out of the way of the regular lorrey, which bears about the same relationship to it that the vestibule limited does to the gravel train on the main line.

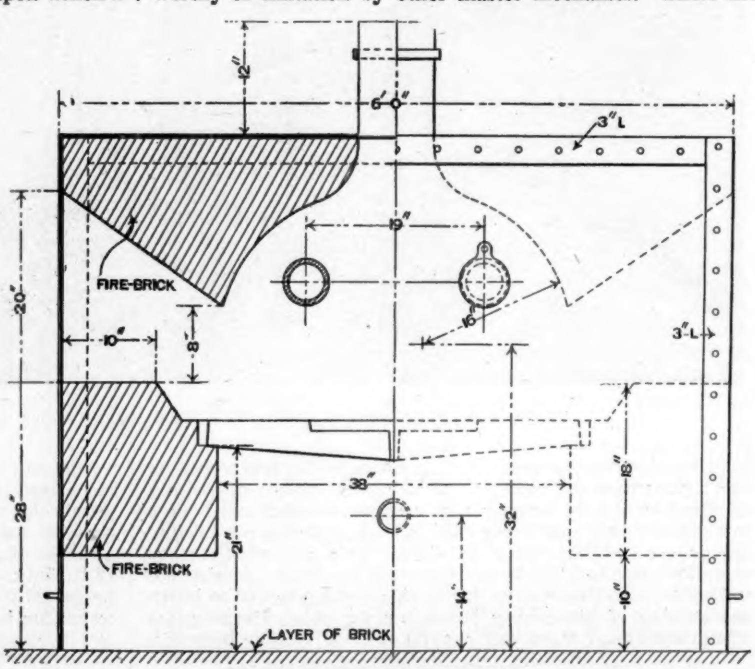
Among the labor-saving arrangements is one which we illustrate by the reproduction of a photograph. There is no drawing of it in existence, but it is simply a contrivance that has been devised by Mr. C. P. Weiss, the Master Mechanic in charge of the shops, to remove the ashes from the elevated ash-pit where the locomotives are dumped. As will be seen, it consists of a four-wheeled car that is heavily ballasted to keep it upon the rails, to which is hung a plow that can be raised or lowered according to the level of the ashes below the rails. Two pieces of railroad iron are run out from either side of the car, and to a cross-bar fastened to their outer ends the supporting bars are fastened. These latter are notched, as shown, to carry the weight, while the nose of the plow is raised by winding the chain on the rod shown at the right. The heel is hinged to the end sill by two heavy hinges, as shown, and it is thoroughly braced at the back. The materials from which this particular plow was constructed were unearthed from the scrap heap, so that the old boiler plates do not present as fine an appearance as though new material had been used. But the proof of the pudding is in the eating thereof; and as this machine will scoop 15 carloads of cinders out of the pit in 15 minutes, it may be taken to be doing fairly efficient work —at least as compared with hand labor.

AT SUSQUEHANNA, PA.

The shops at Susquehanna, Pa., are the headquarters for the great bulk of the locomotive work that is done on the New York, Lake Erie & Western Railroad. The shops are large, and the conveniences for first-class work are such that it can be done. The location is very similar to that of the Lehigh Valley shops at South Easton, Pa. The buildings stand close against an abrupt hill, while on the other side is the main line of railway running along the banks of the river. It is here that the main construction and repair shops of the road for locomotive work are located, no car work being done. A peculiarity in the arrangement of the shops is the location of the transfer table for the pits beneath the roof of the main building. Ordinarily it is not considered necessary that this appliance should be housed in, but the necessity of placing it close under the bank that rises next the shop probably influenced the builders. At any rate, there it is. It is hauled to and fro by an independent locomotive with a very broad gauge. This locomotive is also used to haul the engines on and off the table by means of a rope and snatch blocks. When idle it stands at one end of the shop with its stack beneath a telescope outlet, so as to avoid the discharge of smoke and gas into the building to as great an extent as possible.

There are 26 pits, one of which is straddled by a gallows frame used for the placing of boilers in their frames, and another is arranged with a screw drop table for removing driving-wheels. One space that might have been utilized for a pit is occupied with a lye tank for cleansing the greasy portions of locomotives that are brought in for repairs. In reviewing these shops it is unnecessary and would be uninteresting to our readers to recapitulate the tools in use; but those features of the shop which attract attention are the ones that mark the individual skill and adaptiveness of the men in charge.

Among other things, there is a joint grinder for dry pipes and other parts that has, perhaps, a wider range than the one noted in the Hornellsville shops. Like it, however, it is built of old pieces of drill presses and odd castings that have been discarded from other machines, but which could be readily adapted and fitted for this particular piece of work. It is probable that there are some machines on the market which are especially designed for doing just this class of work, but if there are we do not recall them just at present, and the skill which has been used in arranging these two tools is certainly worthy of imitation by other master mechanics. There are



CLOSED HEATING FURNACE.

also a number of small engines on trucks (most of them having been rebuilt out of old pumps), which can be moved about the shops and located at points convenient for doing such small work as drilling, reaming and tapping; there is a line of steam pipe running down the shop with valve connections at frequent intervals. By means of these connections and a hose steam is carried to the engines, and they in turn are arranged to do the work by means of a Stowe flexible shaft or a rope drive, as the case may require. These Stowe shafts are kept in the storehouse in sufficient quantities, so that they are always available for work of this character.

It is the intention to put an air compressor in the shop, to supply the compressed air, which is now delivered by two Westinghouse pumps in the tool-room. It has not yet been decided whether compressed air will be run into the steam pipes to take the place of steam in driving the small engines

or not. The reason for doing it will be that the exhaust from an air-driven engine is not as disagreeable as a steam engine, besides serving to partially cool the air in hot weather.

Down at one end of the shop there is a shaper arranged for testing stay bolts by a bending stress, which imitates as nearly as possible the stress to which the stay bolts are subjected by the unequal expansion and contraction of the inner and outer shells of the fire-box. The two ends of the bolts are screwed into bars threaded to receive them, and while one is held on the platen of the shaper the other is held in the head and given a reciprocating motion of $\frac{1}{8}$ in. Experiments of this kind have been in progress for some time to determine the relative durability of various metals when subjected to these stresses, but the work has not yet been carried far enough to give any definite results.

Among the novelties at Susquehanna is a small cannon for blowing out rusty bolts. It frequently happens that driven bolts rust in their places so securely that they cannot be pulled out, and their situation is such that a blow cannot be delivered upon them. Caught in just such circumstances as this, a foreman conceived the idea of using gunpowder to do the business. Accordingly a piece of car axle about 1 ft. or 14 in. long was taken, turned off, and bored out to a diameter of about 2 in. until within 2 in. of one end. A touch-hole at the breech and a vent-hole near the muzzle completed the weapon. The projectile is a plug slipping easily into the hole, flat at one end and rounded off at the other where it strikes the blow. With a light charge of powder this plug is blown against the refractory bolt with force sufficient to carry it before it, in one case carrying a footplate bolt through the cab and roof of the shop; but it has never failed to start the object it was fired at. It is a simple thing, and so cheap that the first shot will probably save enough to pay for the making.

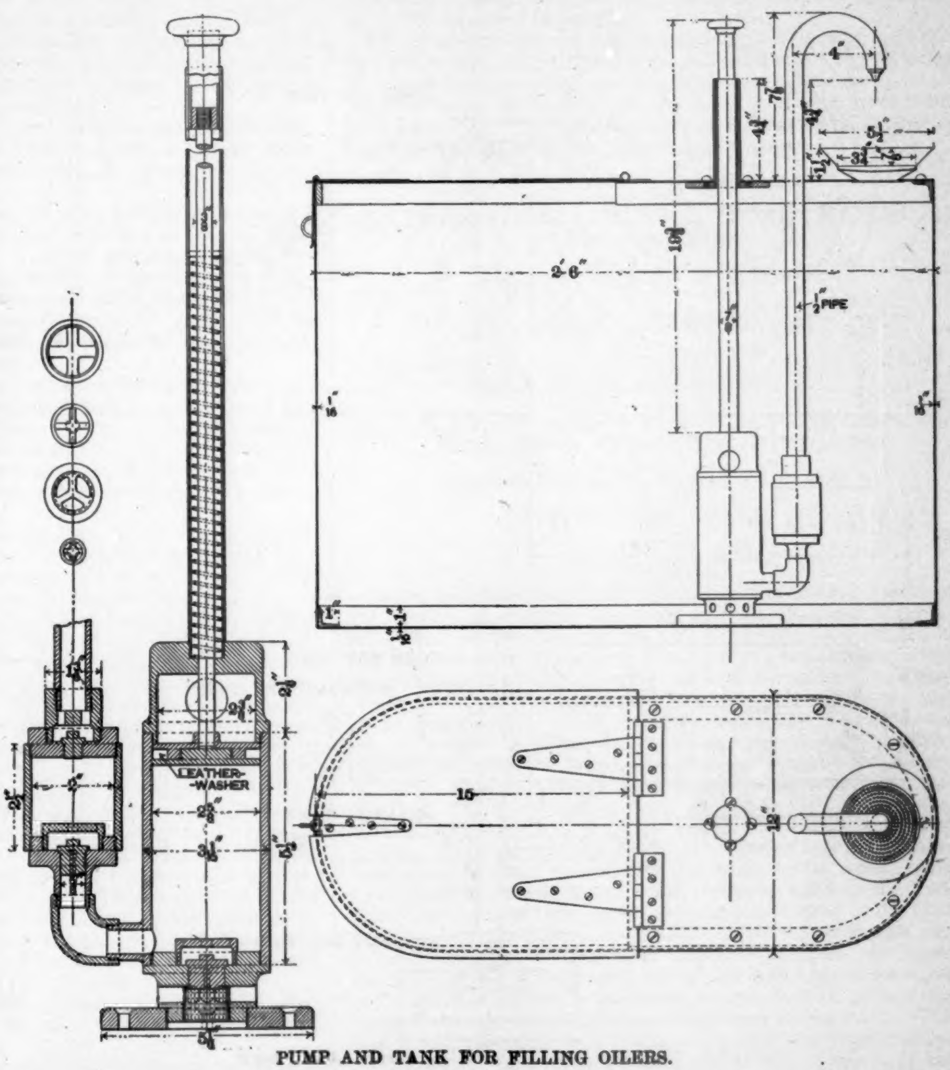
A combination of a planer head and some additions has been evolved into a convenient little machine for milling out the ports of cylinders. A heavy casting and an arbor will soon be placed on the frame slotting machine, changing it into a heavy milling tool, with which the backs and large flat surfaces about the frames can be milled instead of being slotted or planed, thus greatly increasing the capacity of the tool.

It will be remembered that at one of the meetings of the New York Railroad Club last season the subject of taking up side play of locomotive driving-wheels was under discussion. The practice on the New York, Lake Erie & Western Railroad is to drill holes about $2\frac{1}{4}$ in. in diameter in the face of the driving boxes and fill them with projecting blocks of babbitt metal, which bear against the face of the driver and thus take up the wear. This method is giving exceptionally good results, and is cheaper in application than almost anything else which we have seen. Babbitt is also used for filling out rocker boxes, thus avoiding the necessity of supplying new boxes for those whose journals have become somewhat worn.

Another arrangement of tools foreign to their original purpose is that of a planer adapted for grinding guides, the cross feed having been modified so that the wheel is moved at each end of the stroke, the latter being carried on the cross rail and driven by a belt from overhead. Among the interesting tools which have been developed in the shop we publish illustrations of a few, the drawings of which have been kindly furnished us by the mechanical department; among these is a

SLOTTER BAR.

This slotter bar is in reality a tool holder for a slotter, and is so arranged that the tool drops back and clears the work after the manner of a planer tool. The upper part of the bar is $3\frac{1}{4}$ in. in diameter and fits into the head of the slotter; this is bored out from below to a diameter of 2 in., as shown, and into this the tool holder is fitted, being provided with grooves, shown by the dotted lines, into which set screws are run in order to hold the bar in position. At the lower end the bar is



PUMP AND TANK FOR FILLING OILERS.

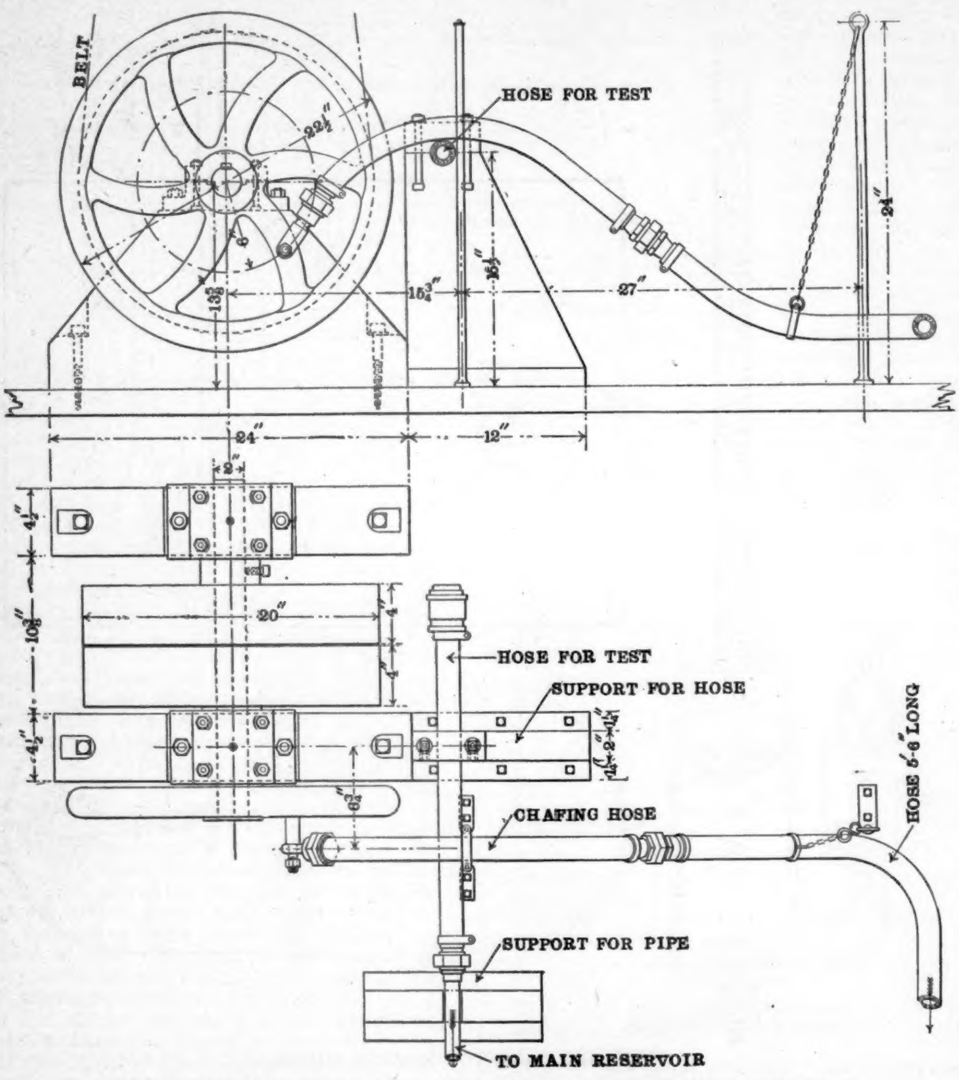
slotted out to take the tool holder itself, which is pivoted on a $1\frac{1}{8}$-in. pin at the point shown. A $\frac{1}{4}$-in. spiral spring is set over the lip of this tool holder, and as it moves upward and is dragged down this spring is compressed and allows it to drop away from the work, while on the downward thrust when cutting the strain is taken by the long arm extending up a distance of $3\frac{3}{4}$ in. above the bottom of the spring.

CLOSED HEATING FURNACE.

About midway down the shop stands a double-ended heating furnace for the use of the tool dresser, who dresses all the tools for the lathes and planers which are used in the machine shop. The furnace is entirely encased in iron, and occupies a floor space of 6 ft. × 4 ft., standing 4 ft. 6 in. high. The corners are bound and strengthened by angle-iron and the interior is thoroughly protected by fire brick put up in the way indicated in the engraving. A furnace thus constructed is not only very convenient for the man who is working it, but is very neat in the shop, making absolutely no smoke and no dirt that is visible, the smoke and gases being carried off in a tight closed stack.

A PUMP FOR FILLING OILERS.

Every foreman of a machine shop is well aware of the difficulties and waste which attend the filling of the oilers that are used about the machines. It is impossible to drill the ordinary man so that he will be as careful about the oil and supplies that are furnished him by the company for whom he is working as he would be if these supplies were paid for out of his own pocket. In filling the oilers, where men are allowed to do it for themselves, it is almost invariably the case that about as much oil is spilled over the outside, on the hands and floor, as is put into the oiler itself. At the same time, where men are using their oilers to any great extent, the time required to get it from the oil-room is so great that the waste would probably be cheaper than the time. In order to overcome this trouble, a tank with a pump attached has been designed, and several of them are located at different points about the shops at Susquehanna. The pump is of such a capacity that by pressing the handle down once sufficient oil will be discharged from the nozzle to just fill the oiler; and as these oilers are seldom taken to be filled until they are entirely empty, very little oil is wasted, and whatever overflow there is runs down through the strainer and back into the tank. A padlock and hasp, shown at the upper left-hand corner of the section, serves to keep the tank free from the meddling of those who would be apt to purloin the oil or drop dirt in the can. The construction is very clearly shown on our engraving. The pump proper consists of a piston without valves. It is raised to its upper position by means of a coil spring acting under the stem. A strainer is placed at the bottom of the cylinder with a wing valve above it. When the piston is pushed down the oil contained in the cylinder flows out at the bottom and through a chamber to which admission is gained through the winged valve shown at the bottom, and which is protected by a cage; these valves form the delivery valves of the discharge. The whole apparatus is so simple and its construction so clearly shown in our engraving that further comment appears unnecessary, and it is shown as a suggestion to others who wish to economize their oil and at the same time have a neat and handy apparatus by means of which to accomplish this end.



HOSE TESTING MACHINE, NEW YORK, LAKE ERIE & WESTERN RAILROAD.

HOSE TESTING MACHINE.

When Mr. A. E. Mitchell, now Superintendent of Motive Power of the road, was Mechanical Engineer at the Susquehanna shops, it became necessary to make some tests of air hose for results beyond those usually attained by the bursting pressures. Upon observation of the hose in actual use it was noted that defective hose did not arise so much from the fact that the hose was burst by an excessive air pressure as that it would wear at those points where it comes in contact with the other hose forming the connections between the cars. It occurred to him, then, that a valuable test for hose would be the chafing test, in which one piece of hose was rubbed over another until the one rubbed gives out, the two being kept under air pressure during the process.

With this end in view, he designed a little machine, shown in the accompanying engraving. The hose to be tested is capped and held in a yoke in the position shown, while the hose which is to act as a chafing hose is hung from a chain at one end and connected to the crank of a wheel driven by belt power. This chafing hose is always of one and the same make, so that no unfairness can arise in the test from one chafing hose having a greater cutting power than another. It will be seen that the hose to be tested is subjected to the rubbing of the test hose at one spot, while the latter takes the bearing over a length of about 12 in., or equivalent to the diameter through which the crankpin moves. As we have already said, both pieces of hose are under air pressure; and when they are coupled the machine is started and run at a speed of 65 revolutions per minute. The results which have been obtained from these tests are such that it has been decided that a piece of hose must stand this rubbing test, before acceptance, for at least six hours, as this is about the average duration of samples which have been submitted for approval, although some specimens have failed in an hour and a half, while others have endured for nearly 30 hours. A marked instance of the value of this test was given shortly after the apparatus was erected. A certain hose manufacturer was unable to get his hose accepted, and objected strenuously to the validity of the test on the ground of general unfairness and inability to detect cheap from well-made hose. In order to satisfy him, he was invited to submit five samples of hose marked with letters, the key of the prices to remain in his own hands and those of the purchasing agent of the railroad, without anything being known as to the value of the hose at the shops; they were subjected to this test, and as a result the cheapest hose gave out in the shortest space of time, and this was followed by the second best, and so on up to the best and most expensive, which endured the chafing for the greatest length of time. Samples of all lots of hose received by the company are now subjected to this test, and it is considered to be the most valuable one that has as yet been devised.

ECONOMY OF DRIVING MILLS AND FACTORIES BY ELECTRICITY.

A CORRESPONDENT in a recent issue of *Indian Engineering* calls attention to the interest which exists in the use of electricity for driving individual machines of large factories, and states that the day is not far distant when electricity will become a successful rival of the old-fashioned manner of distributing power by shafting, gearing, cotton ropes and leather belting. The great losses that occur and are unavoidably present in the last-named systems are so important that it becomes a matter of serious interest to those concerned to take note of the constantly increasing application of electricity to such purposes, the use of which tends so materially to diminish the working expenses.

Having chosen the above title for our letter, and the subject being one that we have specially studied, we venture to think that a few remarks pointing out the chief advantages against the existing disadvantages of the older method will be acceptable to many of your numerous readers.

Such extremely satisfactory results have attended electrical driving in England and on the Continent, that doubtless many changes to this method of transmission of power will soon be made in India.

One great inherent advantage in using electricity is that the distributing agent—viz., the cables—conveys the power practically without loss and only in strict proportion to the demand, while in the case of mechanical transmission by shafting, etc., the loss by friction is considerable, being practically a constant quantity, whether full, partial, or light work is being done—in many cases amounting from 20 to 40 per cent. of the power available.

The longer the distance of transmission and the less the load, the greater is the proportion of loss, and in many cases this becomes a most important matter. Moreover, there is always a considerable dead weight to be rotated, the total shafting, gearing, and pulleys weighing in some cases hundreds of tons, entailing extra strength and cost in structural arrangements to withstand the strain.

From the intermittent character of the work carried out in factories and workshops, it is well known that frequently only a very small part of the power produced by the engine is actually converted into useful work at the machines.

In the present systems of mechanical driving, a single accident to the main driving-belt, shaft, or gears brings the whole establishment to rest; to obviate this is one of the chief advantages of electric transmission. A further objection to the old system is the almost insurmountable difficulties of economical extension; for instance, to increase a 500-H.P. plant to one of, say, 700 H.P. or 800 H.P. would need the almost complete substitution of new and heavier shafting, etc., and great increase in the dead load on the structure generally, while with an electrical installation little or no radical alteration is required.

In the advocated new system of driving, outside the engines or prime movers (which are neglected as being common to both systems), all the shaftings, gears, belts, bearings, etc., are replaced by simple fixed conductors of very small weight and by separate motors to each machine or tool; where, however, the power required does not warrant this, a separate motor is used to drive a group of machines from a short line of light shafting.

These shafts or groups of machines can be placed in any position found most convenient for working regardless of their neighbor.

The nature of electrical generation and dynamo working is such that only sufficient amount of current required to do the work in is used, so its economy is at once obvious.

In factories, where the machinery is working intermittently and liable to great fluctuation, the economy of working is even more marked, as the electric current can be switched on or off with the greatest ease and rapidity, after which crossed belts and fast and loose pulleys appear a heavy and clumsy, not to say unscientific, method of utilizing power.

In electrical transmission 80 per cent. of the power generated by the engine is usefully employed in the machines, and where each machine can have its own motor, a unique and highly economical method of using power is obtained.

It is hardly necessary to point out that no hard or fast law can be laid down; each case must be individually considered and that system adopted which gives the best results.

For old and existing works probably the cost of conversion would seldom be warranted, but for new factories or renovations without doubt the question of driving should be most seriously considered.

In these days of fierce competition and when profits are reduced to their lowest ebb, the careful study of every possible means of economical working is of vital importance to the manufacturers.

The use of electricity for driving all kinds of hoisting machinery is extremely satisfactory and more economical; it is easily and instantly controlled, and allows the driver to concentrate the whole of his attention to the work being handled.

For heavy machinery, such as exists in sugar works, electric driving would, without doubt, be very advantageous in effecting economy and give great convenience in working, and the facility with which electric lighting could be adopted is also an incidental but important advantage to be derived from its use.

Lastly, this system for motive power purposes lends itself most admirably to the subdivision of the motive power engines and dynamos into several units, the consequence being that by this multiplication the chances of total or even serious breakdown are rendered impossible.

Before concluding we should mention that, where factories and mills, etc., are within a reasonable distance—say 10 miles of waterfalls, reservoirs, or mountain streams, when water can be relied upon, the motive power could be obtained from them with advantage by generating current at the site and distributing it to the works by the high-tension system.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

X.—METHOD OF DETERMINING COPPER AND LEAD IN PHOSPHOR-BRONZE.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(*Continued from page 373.*)

OPERATION.

HAVE ready the electrical arrangements described below, or the equivalent of these. Pour the solution of copper and lead salts obtained after the tin has been separated, as described in the Method of Determining Tin in Phosphor-Bronze, into a suitable beaker or electrolyzing jar, and dilute with distilled water to about 200 c.c. Attach the zinc pole of the battery, or its equivalent if other source of electricity is used, to the smaller central electrode, which has been previously carefully cleaned, dried and weighed, and the other pole of the battery or source of electricity to the other electrode, which has likewise been carefully cleaned, dried and weighed. Allow a current of from 0.05 to 0.10 of an ampere to pass from 12 to 24 hours. When it is deemed that the current has passed long enough, add a little water from the wash bottle, taking care not to direct the stream against the pole holding the lead, until the level of the liquid is raised a fourth or half an inch. Allow the current to pass one or two hours longer, and if the bright stem of the copper pole around which the liquid has been raised by the addition of the water, does not show any deposit of copper, it is safe to assume that all but a slight trace of the copper has been removed from the solution. The lead is much smaller in amount, and comes out more readily, and is usually all deposited long before the copper. If the stem of the copper pole shows copper when treated as above, continue the current some time longer, and then repeat the test until the stem remains clean after the current has passed at least an hour subsequent to the last addition of water. The copper being satisfactorily deposited, syphon off the liquid nearly to the bottom of the electrodes, add distilled water and syphon again until about 800 c.c. of water have been passed through the electrolyzing jar or beaker. The current should be allowed to pass during all the time of the removal of the acid, and the washing. The syphoning is perhaps best managed as follows: Have a small glass syphon with a couple of inches of soft rubber tube attached to the longer leg. Fill the syphon with distilled water, pinch the rubber tube shut, and insert the shorter leg inside the copper electrode to very nearly the bottom of the electrolyzing jar or beaker and start the syphon. When the level of the liquid has very nearly reached the bottom of the electrodes, close the rubber tube again by pinching, add distilled water by pouring it inside the copper electrode until the electrolyzing jar or beaker is nearly full again, then syphon off as before, repeating the operation until the required amount of wash water has been added. At the last

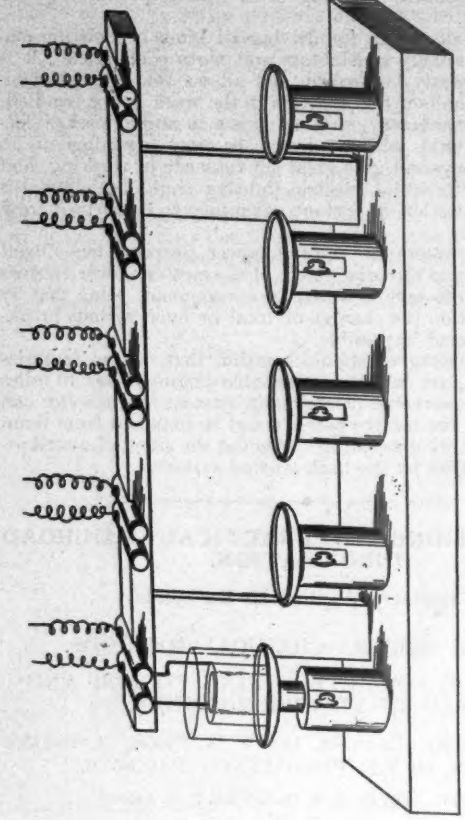


FIG. 4.

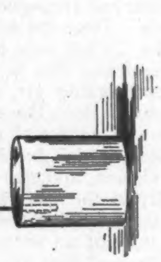


FIG. 3.

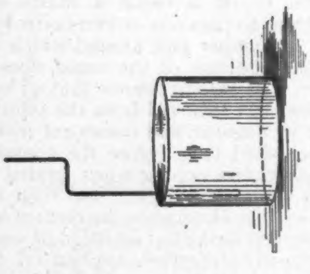


FIG. 2.

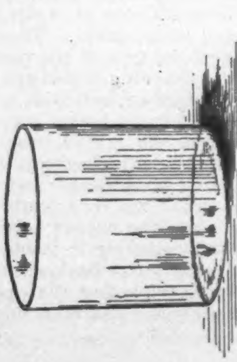


FIG. 1.

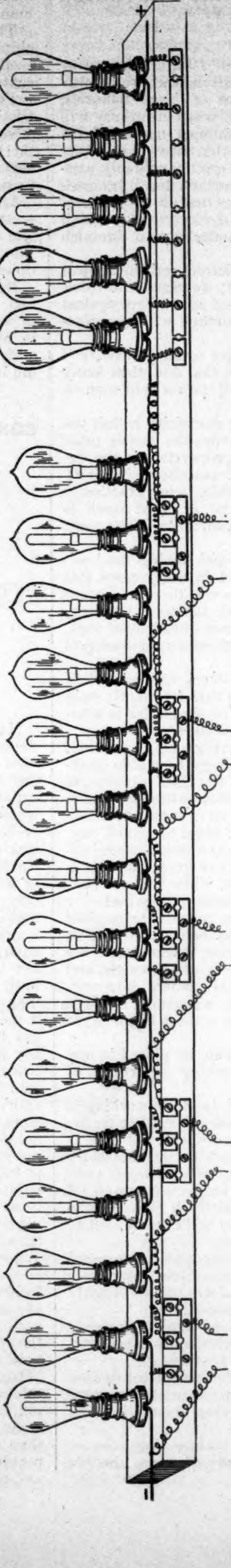


FIG. 5.

draw the liquid down so as to break the circuit. Now lower the electrolyzing jar or beaker, remove the electrode containing the lead carefully, dip it once in a small beaker containing enough distilled water to cover the cylinder, place it vertically on a clean watch glass, set in a warm place for half an hour to dry, and then put in the desiccator; allow to cool and weigh. Remove now the copper electrode, dip once in distilled water and then into a beaker containing enough alcohol to cover the cylinder. Burn off the alcohol remaining, cool in the desiccator and weigh.

If it is desired to determine the zinc and iron which may be present in the phosphor-bronze, they will be found in the electrolyzing jar or beaker and in the liquid syphoned off from this.

APPARATUS AND REAGENTS.

A small beaker about $2\frac{1}{2}$ in. in diameter at the bottom and $3\frac{1}{4}$ in. high can be used for the electrolysis; but a jar made for the purpose, shown in the cut fig. 1, of the dimensions given above, and about $2\frac{3}{4}$ in. in diameter at the top, avoids the flange and lip of the beaker, which are apt to be in the way.

The lead electrode shown in fig. 2 is a cylinder of platinum foil open at both ends, $1\frac{7}{8}$ in. high and 2 in. in diameter. The wire support is $\frac{3}{64}$ in. in diameter, and is riveted to the cylinder. It has an offset to adapt it to the binding posts of the electrical arrangement. The wire projects about 3 in. above the cylinder. This electrode weighs 15 to 18 grams.

The copper electrode shown in fig. 3 is likewise a cylinder of platinum foil open at both ends, $1\frac{5}{16}$ in. in diameter, and same height as the lead electrode. The wire support is same size wire, projects same distance above the cylinder, and is likewise riveted to it. The copper electrode weighs about 12 grams.

The supports for holding the electrolyzing jars during electrolysis are shown in fig. 4. The material, except the set screws and binding posts, is wood. The length of the base is 2 ft. and the width 6 in. That part of the support for the electrolyzing jar which has the set screw is 2 in. in diameter and $3\frac{1}{2}$ in. high. The movable part of the support for the electrolyzing jar is 3 in. in diameter at the top, and the stem is $5\frac{1}{2}$ in. long. The distance from the top of the base to the bottom of the support for binding posts is 11 in. The support for the binding posts is 1 in. thick and 2 in. wide, and the binding posts are so arranged as to support the electrodes symmetrically in the electrolyzing jar. The loose ends of the wires in fig. 4 connect with the loose ends of the wires in fig. 5.

The difference of potential between the binding posts to

which the two electrodes are attached, some two or three volts, is such that with the size of electrodes and volume of solution given above, a current of from five to eight or ten hundredths of an ampere results. This difference of potential may be obtained from a battery of two or three gravity cells ; but since batteries are so difficult to keep in good order, especially if they are not in constant use, and since the Edison current is so common, it is much more convenient to use this current. But the lighting system has a difference of potential of 110 volts between the two wires, and consequently some devices are necessary to bring down the voltage. The arrangement illustrated in fig. 5 has been worked out from the suggestion given in Dr. E. F. Smith's manual of "Electro-Chemical Analysis." It is perhaps more elaborate than is necessary, but where a good deal of work must be done it has been found to be very serviceable. It is fitted up, as will be observed, to carry on five determinations at once. The base of the arrangement is of slate, 4 in. wide, 1 in. thick, and of sufficient length to carry five 16-candle-power 110-volt incandescent lamps and fifteen 12-candle-power 110-volt lamps. It is not essential to have the slate base all in one piece. It will be observed that all the lamps are connected in series, the right-hand end having the positive wire of the Edison circuit attached to it, and the left-hand end the negative. The five lamps grouped at the right of the cut are 16 candle power, and so connected, as is readily seen, with the plugging strips on the edge of the slate that any one, two, three, four, or all of them, can be cut out by simply inserting plugs in the holes made for them. The other 15 lamps are grouped in sets of three each, and are so arranged with plugging strips under each group, as is readily seen, that, when the two free wires are connected through the electrolyzing solution and a plug is in one of the three holes of the group, a shunt circuit is formed. If the plug is in the right-hand hole, the shunt circuit takes in three lamps ; if it is changed into the next hole the shunt circuit takes in two lamps, and if to the next hole one lamp. This arrangement makes it possible to secure a very wide range of difference of potential at the binding posts above the electrolyzing jar. For example, if there is a plug in each of the five holes below the 16-candle-power lamps, and also one in the right-hand hole in the first group of 12-candle-power lamps, the differences of potential at the binding posts connected with this group will be about 23½ volts. Again, if all the plugs under the 16-candle-power lamps are taken out, and the plug under the first group of 12-candle-power lamps is transferred to the left-hand hole, the difference of potential between the binding posts will be about one volt. By varying the plugging, almost any desired voltage between these two extremes can be obtained. It is evident that by using lamps of different capacity, or by using more or less of them, still wider variations of voltage may be obtained. A switch, not shown in the cut, makes it possible to shut off the current when the apparatus is not in use. It is difficult to give positive directions about the plugging necessary in using the apparatus described above, since the voltage in the mains is apt to vary a little with the distance of the apparatus from the central station ; also the switch, the wires and the plugging devices used vary with the different constructions, with corresponding effect on the voltages in the shunt circuits. Still more important also is the variable introduced when one, two, three, four, or five determinations are being made at once. Each new determination introduced changes the voltage at the binding posts of all the others which are in circuit, with a consequent change in the current passing, and hence a change in the plugging becomes necessary to counteract this. The best course to pursue, if an arrangement as above described is made use of, is to connect a delicate ammeter in circuit with the determination and make a schedule of the plugging required when one, two, three, or more determinations are being made at once. It may be said, however, that if the apparatus is approximately as described above, and one or even two determinations are being made at once, successful results will be obtained if there are three plugs in the group of 16-candle-power lamps and the right-hand hole of each group of 12-candle-power lamps has a plug in it. The lamp arrangement is supported on a wooden frame not shown, with the support for holding the electrolyzing jars underneath it. It is desirable to use porcelain sockets for the lamps, as they are not corroded by the fumes in the laboratory, and of course insulated wire should be used throughout for the connections. The plugging arrangements are made of brass, and should be kept well lacquered. Turning the plugs in the holes occasionally keeps the contacts good.

CALCULATIONS.

Atomic weights used : Copper, 63.4 ; lead, 207 ; oxygen, 16 ; molecular formula for lead oxide, PbO_2. The copper being weighed in the metallic state, no reduction is required, consequently the per cent. or amount in 100 parts will be found by multiplying the weight found, expressed in grams, by 100. This may be briefly stated as follows : Move the decimal point of the weight of copper found, expressed in grams, two places to the right. This result will be the percentage of copper in the bronze. Thus, if the weight of copper found is 0.7964 gram, the per cent. of copper in the bronze is 79.64 per cent. The lead is weighed as binoxide ; and since 86.61 per cent. of the binoxide is metallic lead, the weight found expressed in grams, multiplied by these figures, gives the amount of metallic lead in one gram of the bronze. Then the amount in 100 grams, or the per cent., will be found by multiplying this figure by 100. This may be briefly stated by the rule : Express the weight of binoxide of lead found in grams, move the decimal point two places to the right, and multiply by the decimal 0.8661. The product will be the per cent. of lead in the bronze. Thus, if the weight found is 0.1462 gram, the percentage will be [14.62 × 0.8661] 12.66 per cent.

NOTES AND PRECAUTIONS.

It will be observed that this method separates the copper and lead from nitric acid solution by means of electricity, the copper being thrown down on one pole in the metallic state, and the lead as binoxide on the other pole.

In order to get a proper separation of lead and copper by means of the current in nitric acid solution a certain amount of free acid is necessary. Dr. Edgar F. Smith's manual of "Electro-Chemical Analysis" states that not less than 5 per cent. is requisite. It will be remembered that 15 c.c. of concentrated C. P. acid are added on separating the tin, a little of which is probably evaporated, so that if the bulk of the solution is made 200 c.c. as directed, the amount of free acid is from 7 to 8 per cent.

Notwithstanding the amount of copper to be precipitated is quite considerable, by far the largest portion of it comes out with the appliances as described in about 12 to 15 hours, so that if a rapid result is desired it is safe to begin testing at the end of that time. When a complete analysis of a bronze is being made, the other constituents are usually not obtained sooner than 24 hours after starting, so that no loss of time results if the current is allowed to act for that time, and the certainty of getting the copper is somewhat greater with the longer time.

In burning off the alcohol from the copper electrode, no additional heat beyond that furnished by the alcohol should be used or there will be danger of oxidizing some of the copper.

The separation of the copper from the solution by the current is perhaps never absolutely complete. However long the current may be passed, it is rare that some slight reaction is not given when the acid solution is tested with hydrogen sulphide. The amount left in solution can, however, usually be ignored if the current has been passed 24 hours.

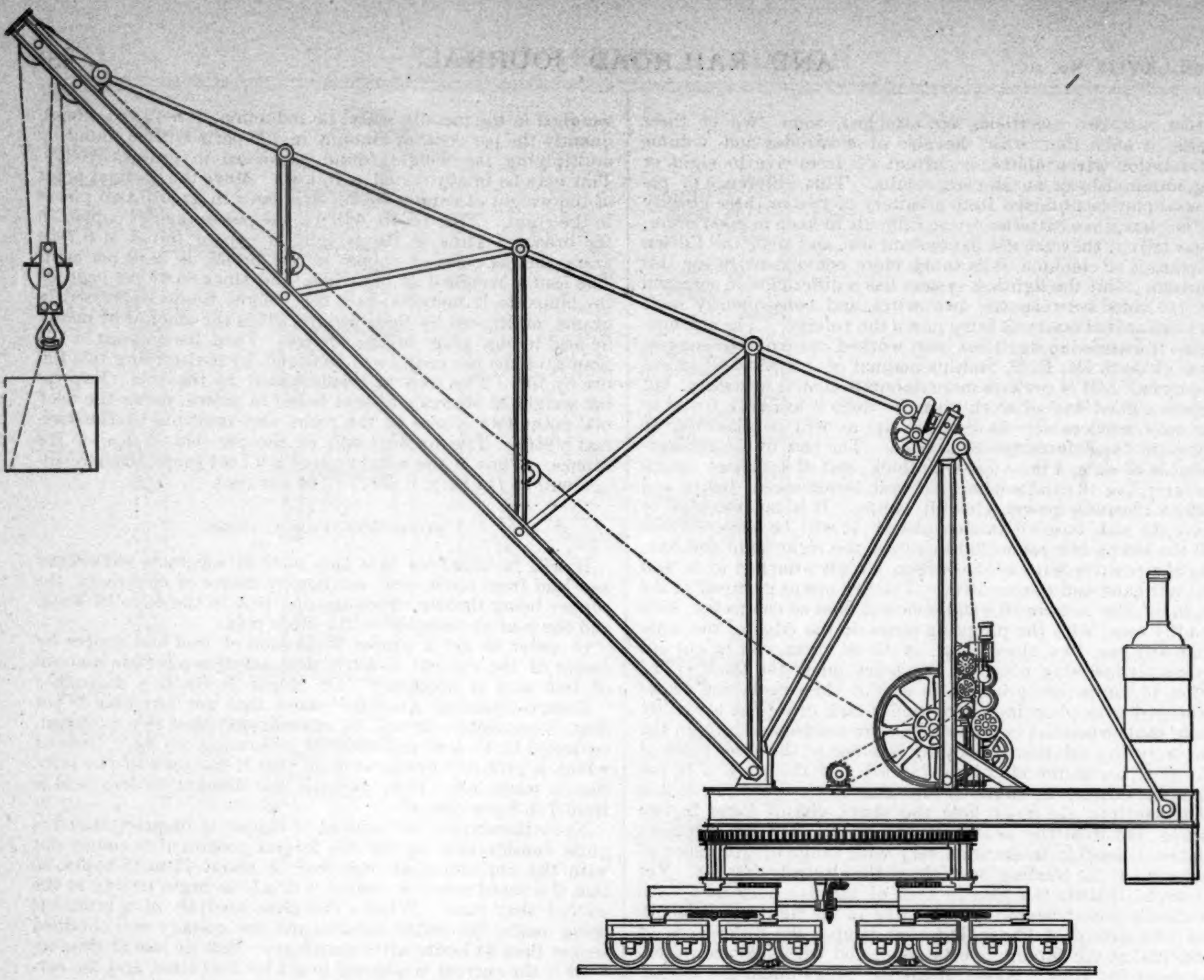
The binoxide of lead adheres to its electrode sufficiently well, so that with careful manipulation there is no danger of loss, but a direct stream of water against this electrode when the oxide is on it will detach some. A severe jar will do the same. The copper adheres well if too strong a current has not been used, and there is little danger of loss with any reasonable manipulation.

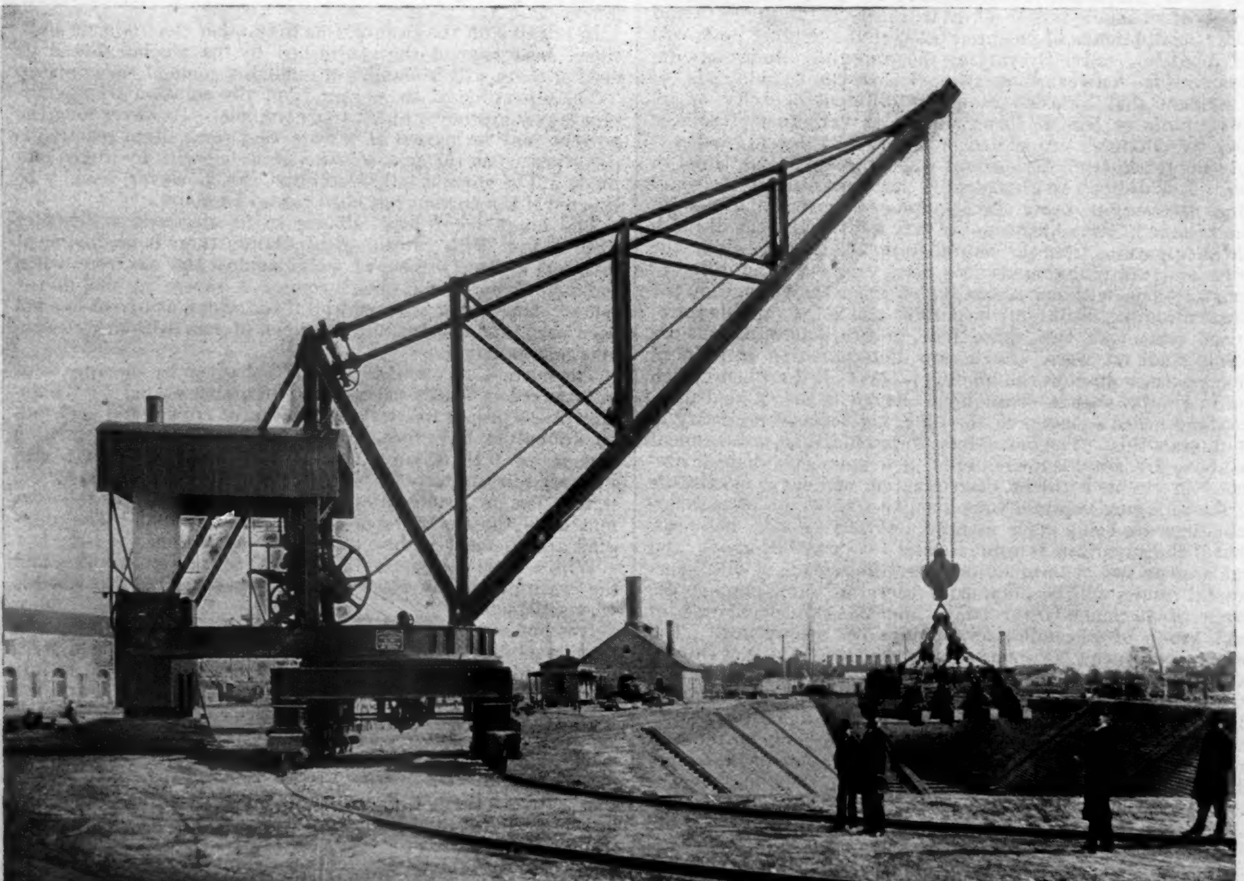
The current recommended and that given by the apparatus as arranged is somewhat greater than that stated by the authorities as proper for the precipitation of copper and lead, but no difficulties have been experienced when working with a current of 0.10 of an ampere. Indeed, at the last a still stronger current may be safely used. It is advisable at the start to use not over 0.05 of an ampere, and continue this current until the electrodes are fairly well covered. The plugging arrangement enables this to be readily done.

With a little experience the removal of the acid solution and the washing of the electrodes by syphoning as described is very satisfactory.

It is obvious, since nitric acid is present, in which copper is readily soluble, if the current is shut off before the acid is removed and the washing finished, there will be danger of loss of copper.

If there is any silver present in the bronze, which is often the case, this is thrown down with the copper and weighed as such. This error is usually ignored, the amount of silver being generally not more than six or eight hundredths of a per cent. If there is any bismuth present in the bronze, the largest part of it goes to the lead pole, causing in some bronzes quite a serious error. Consequently, if the lead found by the above-described method exceeds the limits of the specifications on which the metal was bought, a supplementary determination of the lead is always made, the lead being determined as





40-TON DOCK CRANE AT THE NORFOLK, VA., NAVY YARD. BUILT BY WILLIAM SELLERS & CO. PHILADELPHIA, PA.

sulphate before final action is taken in regard to the shipment.

The electrodes are readily cleaned after a determination is finished by immersing the cylinders in a beaker of dilute nitric acid, and allowing the two wires to touch above the beaker. A little battery cell is thus formed which soon dissolves the lead oxide and copper.

In case a little of the lead oxide becomes detached from the electrode and falls to the bottom of the electrolyzing jar, it may usually be recovered by adding alcohol after the syphoning is finished, and washing by decantation several times, and finally transferring by means of an alcohol wash bottle to a weighed watch glass, sucking off most of the excess of alcohol with a pipette, drying and weighing. The lead oxide is quite bulky, and it requires considerable of it to weigh a milligram. Of course, if any serious amount of it becomes detached, the determination should be repeated, using less current.

A small watch glass cut into two equal parts, and each one of the halves put on opposite sides of the wires of the electrodes, makes a convenient cover to keep out dust during the electrolysis.

A 40-TON DOCK CRANE.

The Navy Department have now in use at the Brooklyn and Norfolk Navy Yards a 40-ton dock crane, built by William Sellers & Co., Incorporated, of Philadelphia, which is specially intended for placing armor plates on the vessels built at these yards. The cranes are located on a track running around three sides of the dry dock, the jib of one of them being seen over the stern of the United States battle-ship *Texas*, shown in our engraving on page 149 of the issue for April of this year. The fourth side of the dry dock is left clear for the entrance of the vessel. It was an essential requirement of these cranes that they should go around curves of 84 ft. radius, measured to the center of the outside rail. This necessitated an arrangement of trucks which would compensate for this short curvature. It is very evident, also, that the crane should be capable of being moved about as the work demands, and that it should be preferably self-propelling in order that it may be perfectly independent and moved through longer or shorter distances as the proper adjustments of the plates may demand.

The tracks upon which the cranes run have a gauge of 18 ft. Our two illustrations give a very clear idea of the general appearance and construction; the line engraving having been supplied us by the *Iron Age*, while the half-tone engraving is a direct reproduction of a photograph supplied by the makers. The working capacity of the crane is 40 gross tons, at a radius of 50 ft. measured on the center line of the bearing pins of the jib, and the machinery is so arranged that it is capable of hoisting or lowering, turning or traveling, simultaneously or independently as the work may require; the machinery is also so geared that all of the motions can be readily reversed without reversing the engine. In addition to its load of 40 tons the jib is arranged to a pivot on the upper platform of the car, and is held in place by two large screws, which two can be moved so as to increase the radius of the hook 14 ft., making it 64 ft. from the fulcrum pins of the jib instead of 50 ft., and making the maximum radius from the center of the rotating platform 70 ft. instead of 56 ft. The maximum load at this radius is 30 gross tons.

The rotating platform which carries the machinery, adjustable jib and boiler, is counterbalanced at its outer end by a box containing slabs of cast iron, of a total weight of about 60 tons. This counterweight is so proportioned as to balance the loaded and empty crane, keeping the center of gravity of the mass within the circle of rollers on the crane car.

The crane is driven by a pair of 10 in. × 12 in. engines, and the various changes and motions of hoisting and lowering, turning and traversing, is accomplished by means of friction clutches. The load is also automatically sustained at all points by a patent retaining device, without attention of the operator, it being necessary to lower by power. The load is carried upon three parts of chain, the free end being wound upon the drum with a single coil without overlapping. This chain is made of tested links of 1⅜-in. round iron. The drum upon which it is wound is of wrought iron; the bearing ring for the rollers, which required a harder material, has been made of steel castings. The circular web is of two plates, and all angles are in one length, the ends of no two of them meeting in the same vertical plane.

The maximum speed of the crane is 50 ft. per minute. There are two hoists, one being a slow speed of from 5 ft. to 7 ft. per minute, while the other is a rapid hoist, for weights running up to about 15 tons, and has a speed three times that of the first. The operating clutches are arranged in pairs upon the horizontal shafts, each pair being controlled by a single lever, so that in a central position no motion will result. The forward movement of the lever will produce a corresponding motion of the crane in one direction, while the backward movement of the lever produces motion in the opposite direction. The work is thus perfectly under the control of the operator at all times and by very simple means.

Such a crane as this is not only an advantage, but absolutely necessary to an economical performance of such work as the location of armor plates and heavy work of a similar character about our battle-ships and cruisers, and this one has been so designed that its working has given the utmost satisfaction.

RECENT EXPERIENCES WITH CYLINDRICAL BOILERS AND THE "ELLIS AND EAVES" SUCTION DRAFT.*

By F. Gross.

At the last summer meeting Mr. Ellis read a paper on "Some Experiments on the Combination of Induced Draft and Hot Air Applied to Marine Boilers Fitted with Servé Tubes and Retarders." So much special attention is being given to boilers for ships at the present time, that it will perhaps interest the members to be informed of the experience which has been gained to date with this system applied to marine boilers on land and at sea. The boilers which have been working longest with this combination are at the Atlas Works, Sheffield. Nos. 7 and 8 are now three years old; Nos. 9 and 10 are two years old; Nos. 11 to 16 have since been gradually added. These 10 single-ended marine boilers, placed together in one shop, furnish part of the steam required by the works, and are at work day and night. Their ordinary work is to maintain a regular combustion due to 3 in. vacuum at the fan inlets, corresponding to a combustion of 35 lbs. to 37 lbs. per square foot of grate, which is uniformly 5 ft. 8 in. long in all the boilers. For short periods, at certain intervals during the day, the quantity of steam required is appreciably greater than the regular quantity, when, by increasing the number of revolutions, the rate of combustion is immediately raised to 40 lbs., 45 lbs., 50 lbs., or even 60 lbs. per square foot of grate, and as promptly reduced when the demand for the extra steam has passed away. It will be evident that, unlike boilers with natural draft, the boiler is the constant quantity, while the draft is varied largely according to the requirements for the time being.

For the purpose of obtaining data on suction-draft fans, different diameters and widths are used. Moreover, some fans work one boiler only, and are placed above the boilers; others work two boilers, and are placed on the ground floor, sucking the gases downward, and discharging them into short funnels, which just clear the roof of the building. The success of boilers Nos. 7 and 8 led to the construction of Nos. 9 and 10, and the satisfactory experience with the four, to the subsequent further six, partly for the sake of space, partly for economy and absence of smoke. The 10 boilers, 10 ft. 6 in. by 10 ft. 6 in., displace three to four times as many Lancashire boilers of about 28 ft. by 6 ft. 6 in., while the evaporation per pound of South Yorkshire coal is 9 lbs. actual from cold feed —or 10½ lbs. from and at 212°—when burning at 30 lbs. per square foot of grate, or 8¼ lbs. actual feed—or 10 lbs. from and at 212°—when burning at 45 lbs. per square foot of grate, as against 6¼ lbs. actual from cold feed in the Lancashire boiler burning at 19 lbs. per square foot of grate with a chimney 130 ft. high. Very recent careful examination of the boilers shows that the Purves flues, tube plates, and Servé tube ends in the oldest are as good as new; and it is worthy of special note that the feed-water comes cold from the river, unfiltered, and that the draft is not shut off when the doors are opened for firing, slicing, or raking. The dampers are used only when the fires are being cleaned—every six hours. The fans likewise continue to work satisfactorily, as anticipated, because the gases when entering the fans do not exceed 450° at the highest rate of combustion, the air heated by the waste gases then entering the furnaces at 320°. For these boilers, owing to the steam pressure being as yet unavoidably only 50 lbs. per square inch, the fan engines are simple engines.

The International Company's steamship *Berlin* — better known under the old name of the Inman Company's *City of*

* Paper read before the Institution of Naval Architects on July 26, 1894.

Berlin—was the first steamer fitted with the draft, as conveniently as the position of the eight single-ended boilers facing the center longitudinal line of the ship permitted. The air-heating tubes had in this case to be placed across the front instead of lengthwise of the boilers, offering consequently more obstruction, with less effective heating surface, than when placed in the usual way. She has been working hard since March 1, 1893, with satisfactory results, and has burnt at an average rate of 26 lbs. per square foot of grate, 5 ft. 3 in. long.

The same owners adopted this draft for the two new steamers built in this country and recently completed—viz., the steamship *Southwark*, by Messrs. Denny, and the steamship *Kensington*, by Messrs. J. & G. Thomson, Clydebank. They are twin-screw sister ships, 480 ft. long by 57 ft. wide by 40 ft. deep. The main engines are quadruple-expansion, and intended to develop 7,000 I.H.P. in each ship at trial trip. The *Southwark* has two double-ended main boilers, 15 ft. $9\frac{3}{16}$ in. mean diameter by 21 ft. $8\frac{3}{4}$ in. long, and one single ended, 15 ft. $9\frac{3}{16}$ in. mean diameter by 11 ft. 1 in. long. Each of the five boiler ends has four Purves furnaces 3 ft. 4 in. inside diameter, grate bars 5 ft. 9 in. long. Total grate surface, 383 sq. ft. Total heat-distributing surface inside the boilers, 12,285 sq. ft. Working pressure, 200 lbs. Each boiler end has one exhausting fan 7 ft. 6 in. diameter, and separate self-acting engine by Messrs. Sturtevant, of Boston, United States, these engines being used freely in the International Company's steamers. The Servé tubes in the boilers are $3\frac{1}{4}$ in. outside diameter. At the trial trip with a displacement of 12,300 tons, she easily developed the expected power, and gave the mean speed of 16.3 knots. On her station she has been running four round voyages, Liverpool to Philadelphia, almost entirely with the two double-ended boilers only at work, with an average combustion of $27\frac{1}{4}$ lbs., which will gradually be increased. In the *Kensington* the boilers are slightly longer, the double-ended 21 ft. 7 in. and the single-ended 11 ft. 5 in. The total heat-distributing surface inside the boilers is slightly less—viz., 11,672 sq. ft. The number and size of Purves furnaces, the length of grate bars, and diameter of Servé tubes are the same as in the *Southwark*. At the trial trip, with a displacement of 12,400 tons, she gave a mean speed of 15.8 knots. She has run one voyage West so far.

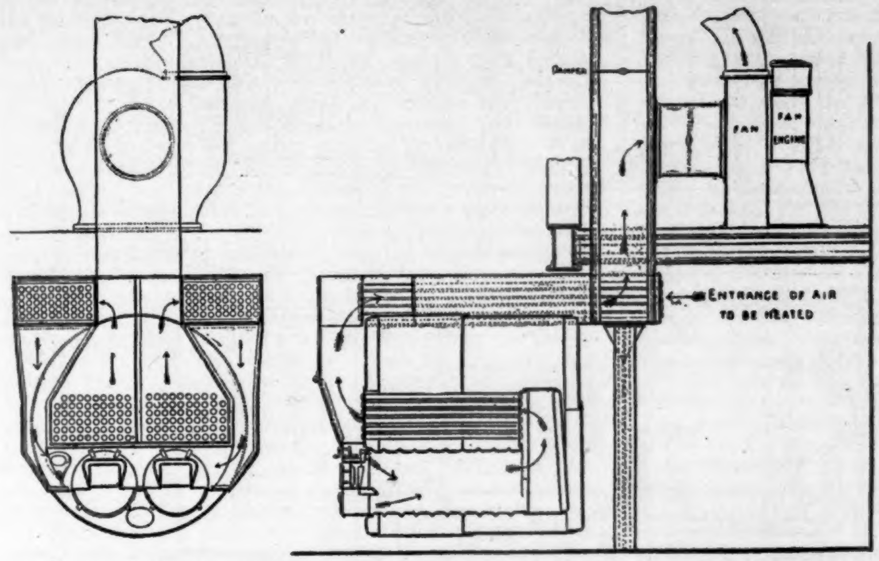
While the foregoing steamers are giving experience for the Atlantic service, two other large steamers are doing the same for the long voyages to and from Australia. Messrs. Turnbull, Martin & Co., London, in the Australian dead meat trade, have this combination draft in their new sister ships, *Perthshire* and *Buteshire*, built by Messrs. Hawthorne, Leslie & Co., Newcastle. These ships are 435 ft. long over all, 54 ft. wide, and 32 ft. deep. Displacement when fully loaded, 12,000 tons. For the power of 3,000 I.H.P. in each ship there are two single ended boilers, 15 ft. 6 in. diameter by 12 ft. long, each with three Purves furnaces, 3 ft. 9 in. inside diameter, and grate bars 5 ft. 9 in. long. Total grate surface in each ship, 127 sq. ft. Heat-distributing surface within the boilers, 4,770 sq. ft. in each ship. Working pressure, 160 lbs. The fans and triple-expansion fan engines are of Messrs. W. H. Allen & Co.'s make. Each ship has completed one round voyage to Australia and back. On the outward voyages, with an average indicated H.P. of main engines of 2,450 to 2,500, the coal consumption averages about 26 lbs. per square foot of grate. On the home voyage, requiring considerable extra steam for the large refrigerating machinery, the *Perthshire* averaged a combustion of $31\frac{1}{4}$ lbs. over nine consecutive days, and the *Buteshire* $27\frac{1}{4}$ lbs. per square foot of grate over 56 consecutive days. The coal consumption of Newcastle small coal on the outward voyages averages 1.345 lbs. per indicated H.P. of main engines. This includes the power required by the fan engines. With South Wales coal the consumption of main engines will, therefore, be under 1.3 lbs. per indicated H.P., after finding the power for the fan engines. Although the boilers of the *Perthshire* had been continually under steam for 75 days, being worked for 59 days at this, for Australian voyages, unprecedented rate of combustion, the furnaces, tube plates, tube ends, and the fans were found in good order on arrival in London. These owners are fitting the draft arrangement to a third sister ship, the steamship *Banffshire*, now building by Messrs. Hawthorne, Leslie & Co.

Briefly summarized, the experience to date may be considered to have established a rate of combustion on a grate 5 ft. 9 in. long of 30 lbs. to 60 lbs. in marine boilers on land, and of 26 lbs. to $31\frac{1}{4}$ lbs. at sea in the Atlantic and Australian services, without trouble to furnaces, tube plates, tube ends, fans and fan engines, accompanied by an appreciable economy compared with the boilers of the same size with plain tubes working with natural draft at half the rate of combustion. The main factor in the economy is, of course, the Servé tube in combination with the retarder, because the Servé tube has on an average at least 75 per cent. more heat "absorbing" surface than the same diameter of plain tube. The result is that at the highest rates of combustion, and with $3\frac{1}{4}$ in. diameter tubes—permitting natural draft to be readily used—the gases, when they reach the smoke-box, do not exceed 700°. The heat-absorbing surface of the air-heating tubes completes the economy, the gases reaching the fans cooled down to 300° to 400°, having heated the air to from 200° to 300°, according to the rate of combustion and amount of absorbing surface. Against close stokehold forced draft, burning at the same rate of combustion with plain tubes, the weight of the boilers with this system will be greater, but there is a considerable net saving in weight for other than short cross Channel voyages through the economy in fuel, which is naturally greatest against closed stokehold cold-air draft. At a combustion of 30 lbs. per square foot of grate this economy will be at least 15 per cent. Against Mr. Howden's latest practice the loss of weight is trifling, being practically only the extra weight of the ribs in the Servé tubes and of the greater surface of the

PARTICULARS OF SHIPS AT WORK WITH THE "ELLIS & EAVES" COMBINATION DRAUGHT.

	S.S. Berlin.	S.S. Southwark.	S.S. Kensington.	S.S. Perthshire.	S.S. Buteshire.
Length of ship	488 ft. 6 in.	480 ft.	480 ft.	435 ft.	435 ft.
Width " "	44 " 0 "	57 "	57 "	54 "	54 "
Depth " "	36 " 9 "	40 "	40 "	32 "	32 "
Displacement at trial trip—tons	....	12,300	12,400	7,500	....
Number of boilers	8 single-ended.	2 double-ended and 1 single-ended.	2 double-ended and 1 single-ended.	2 single-ended.	2 single-ended.
Size " "	13 ft. $2\frac{1}{2}$ in. mean diam. × 11 ft. $4\frac{1}{2}$ in.	15 ft. $9\frac{3}{16}$ in. mean diam. × 21 ft. $8\frac{3}{4}$ in. 15 ft. $9\frac{3}{16}$ in. mean diam. × 11 ft. 1 in.	15 ft. 9 in. mean diam. × 21 ft. 7 in. 15 ft. 9 in. mean diam. × 11 ft. 5 in.	15 ft. 6 in. mean diam. × 12 ft.	15 ft. 6 in. mean diam. × 12 ft.
Number of furnaces	24	20 Purves.	20 Purves.	6 Purves.	6 Purves.
Inside diameter of furnaces	3 ft. 2 in.	3 ft. 4 in.	3 ft. 4 in.	3 ft. 9 in.	3 ft. 9 in.
Length of grate	5 " 3 "	5 " 9 "	5 " 9 "	5 " 9 "	5 " 9 "
Total heat distributing surface in boilers, reckoning outside surface of tubes	14,616 sq. ft.	12,285 sq. ft.	11,672 sq. ft.	4,770 sq. ft.	4,770 sq. ft.
Total grate surface	396 "	383 "	383 "	127 "	127 "
Working pressure	150 lbs.	200 lbs.	200 lbs.	160 lbs.	160 lbs.
Number of fans	4	5	5	2	2
Size " "	7 ft. 6 in. diam.	7 ft. 6 in. diam.	7 ft. 6 in. diam.	8 ft. diam.	8 ft. diam.
Mean speed developed at trial trip—knots	....	16.3	15.8	11.75	....
Average revolutions of fan engines	360	317	....	320	....
Number of voyages	17	4	....	1	....
Average I. H. P. of voyages	5,566	4,446	....	2,450 outwards.	....
" coal consumption per I. H.P.	....	....	....	134 lbs. Newcastle Sm.	....
Temperature of air before entering furnaces	260°	271°	....	220°	....
Temperature of gases at fan inlet	441°	393°	....	310°	....
Vacuum at fan inlet	3 5 in.	2.9 in.	....	1.75 in.	....
" over fires	1.1 "	.8 "	....	.2 "	....

air-heating tubes, and these produce a distinct advantage in economy in fuel of at least 7½ per cent. In a number of steamers working with Mr. Howden's draft, the substitution of Servé tubes for plain tubes has at once given an economy of 10 per cent., and it will be conceded that the horizontal air-heating tubes in the suction draft will be more effective than vertical tubes. Even with natural draft, with a funnel height of 75 ft. or more, the Servé tube has proved in a considerable number of vessels that it gives an economy of 10 per cent. over plain tubes in the same boilers, and the special advantage of this suction-draft combination is to give the same economy when burning at twice the rate in half the number of boilers, or to make the steam as economically as is now done with natural draft and plain tubes when burning at three times the rate in one-third the number of natural-draft boilers.



BOILER WITH ELLIS & EAVES' HOT-AIR AND SUCTION SYSTEM.

Taking, therefore, boilers and coal together, this system requires in reality for moderate and long voyages the least weight of cylindrical boiler for a combustion of 25 lbs. per square foot of grate and upward: and, as the action of the suction-draft is to heat the boilers more uniformly the higher the rate of combustion—therefore the opposite of forced-air pressure draft—it is probable we shall gradually see the boilers reduced more and more in size, and the rate of combustion at sea increased to 40 lbs., 50 lbs., and upward per square foot of grate. Electric motors with small fans will assist in this direction, and the economy, safety, and comfort of this system in working are strong recommendations for large passenger and cargo boats, while for warships the power to do away entirely with smoke, and even with funnels, should not be without importance. The accompanying table gives the principal data for the five ships grouped together for handy reference.

PROGRESS IN GAS MOTORS FOR STREET RAILWAYS.

In a recent issue of the United States Consular Reports Mr. Frank H. Mason, our Consul-General to Frankfort, contributes the following interesting information on the subject of gas motors for tramway purposes. Referring to the Lührig model of a street car propelled by a gas engine, and carrying its supply of compressed gas in cylindrical reservoirs hung beneath the floor of the vehicles, he says that, although of recent invention and somewhat complicated in construction, this car had been worked successfully in Dresden at a net cost of operation so far below that of electric or even horse railways that it seemed to embody the germ at least of a new and important departure in street railroad equipment, particularly for the large class of lines whereon traffic is limited and varies essentially in volume at different seasons or hours of the day. Through the death of the inventor and other circumstances, the ardor of improvement appears to have been temporarily checked in Germany, and the field of experiment has been transferred to England, where the Lührig patents have been acquired by a syndicate, and the car has undergone, during the past four or five months, modifications which, from trustworthy accounts, have greatly lessened its weight and cost and enhanced its practical value.

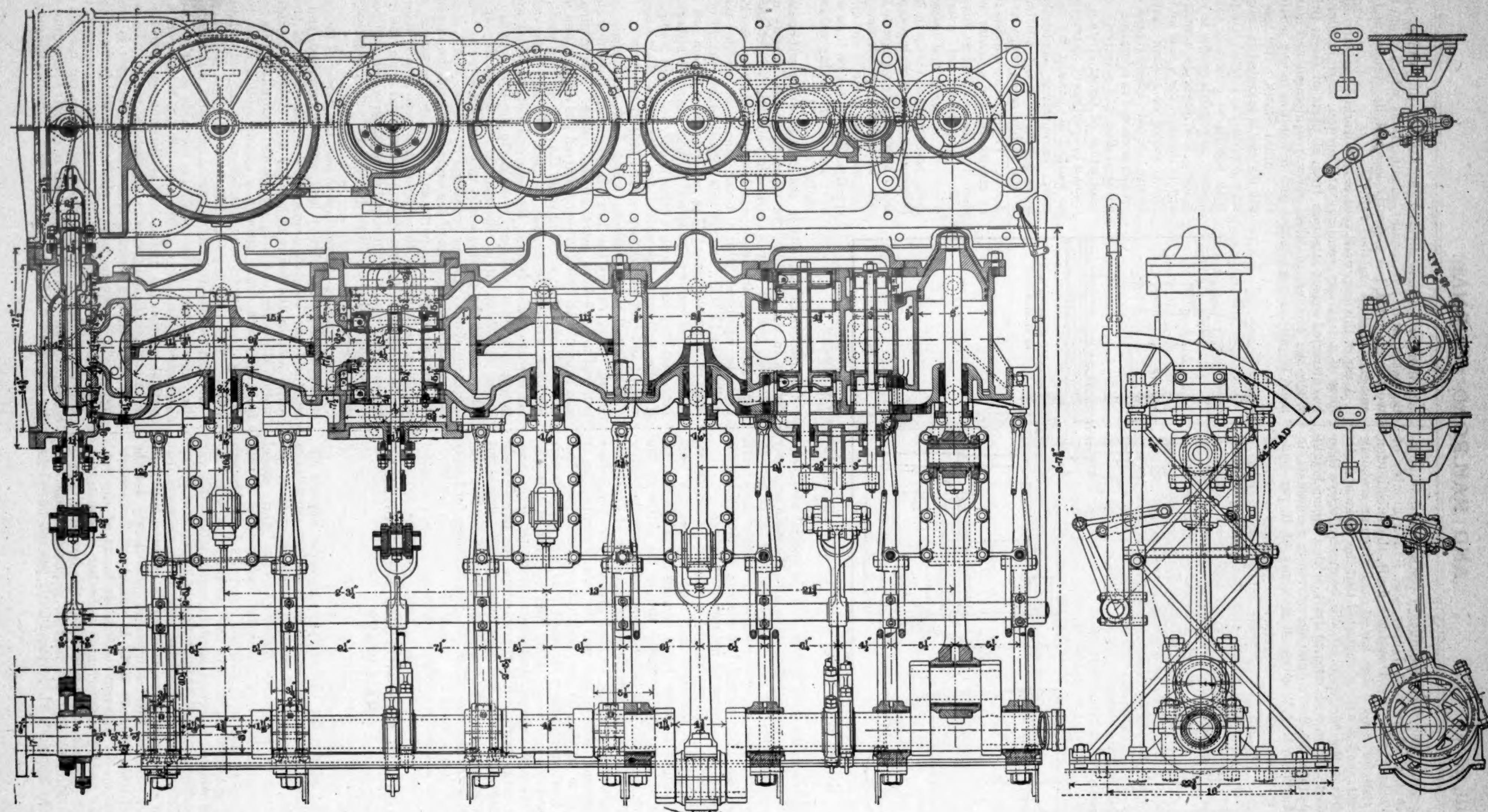
A car of this improved type is now worked regularly on the lines of a tramway company at Croydon, near London, and has attracted expert attention from all parts of Great Britain, where the problem of street railway equipment and management is quite as complicated and difficult as in any portion of the United States. Not less than $70,000,000 is invested in tramway lines within the United Kingdom, with results so generally unsatisfactory, as regards profits to stockholders, that there is a wide and urgent demand for a new and simplified motor or system that will secure equal effectiveness and greater economy in operation. Notwithstanding the relatively dense population of Great Britain, only a small proportion of its tramways, as worked at present by cables, steam locomotives, electricity, or horse power, are really satisfactory to the public or pay regular dividends. The same need exists there, as elsewhere, for a motor which shall be clean, noiseless, manageable, independent of overhead wires or underground constructions, and withal so cheap in initial investment and working expense as to successfully supersede horse cars, to which there are many objections on the score of cleanliness, speed, and economy on lines which have a light or varying volume of traffic.

One important difficulty in the case of every self-contained car lies in the fact that, for climbing grades, starting under full load, passing curves, or meeting sudden falls of snow, a car which, when in motion, can be easily drawn by two horses must be equipped with a motor capable of exerting temporarily 10 or 12 H.P., and for this a considerable weight of machinery is unavoidable. The general defect which has been found in gas motors for street railway purposes hitherto has been that they have been available only for light traffic, and, if made sufficiently powerful for city lines, their excessive weight and cost would form a fatal objection.

Through the modifications which have been made in the Lührig motor car by the English engineers, these defects are believed to have been practically overcome. The original car was rigged with two double-cylindered gas engines, one under each seat, and both working upon the same driving shaft, and weighed, without passengers, 7½ tons. In the improved car but one gas engine is used, the two cylinders of which are set facing each other, and both working to the same crank. The engine is located under the seat on one side of the car; the other end of the driving shaft, which extends across beneath the floor of the vehicle, carrying a fly wheel, which steadies and regulates the motion of the engine. By this improvement the number of working parts, and, therefore, the weight, cost, and wear and tear of the motor, have been greatly reduced. What is equally important, in a commercial sense, the motor has been reduced to a form and dimensions which will permit it to be adjusted to cars already built for cable, electricity, or horse power.

But by reducing the engines to one, the power of the car to start promptly with a heavy load was compromised, and this weakness has been overcome by the momentum of the fly wheel and by the device of keeping the engine constantly in motion while the car is in service and transmitting its power from the crank shaft, through a second-motion shaft, to the running gear by friction clutches under the control of the driver. This is arranged as follows:

The driver, standing on the front platform, has before him the brake wheel, and beside him a movable lever not unlike the reversing bar of a locomotive. When this lever is in a vertical position the engine shaft is disconnected from the second-motion shaft and the axles, so that the car may be at rest while the engine is running free. When the lever is pushed to the right the second-motion shaft, with which the axles are connected by chain gearing, is brought into engagement by a pinion and friction clutch, which gives the car a speed of 4 miles per hour. Shoving the lever to the left brings into similar engagement a larger pinion, which, without changing the



QUADRUPLE-EXPANSION ENGINE FOR THIRD-CLASS TORPEDO BOAT FOR THE UNITED STATES BATTLESHIP "MAINE."

speed of the engine, gives the car a pace of 8 miles an hour, which is the limit of speed allowed by the municipality of Croydon. A second lever is provided for operating reversing clutches whenever, at the end of the line or elsewhere, the movement of the car has to be reversed. The friction clutches, which form so important a feature of the machine, are made of hard wood set between the two disks of iron, and are said to be effective and durable.

There must be, of course, some device to regulate the speed of the engine and keep it as nearly as possible uniform while the car is stopped and under the varying conditions of grade and load. This has been provided for with great ingenuity—first, by a governor, which, when the work is light, cuts off automatically the gas supply from one of the cylinders, leaving the other to do the work alone, and, still further, through a mechanical connection between the governor itself and the lever, already described, which operates the clutches. When this lever is upright and the engine shaft disengaged from the axle gearing, a weight on the spindle of the governor is lifted which cuts off the gas at half stroke in the one working cylinder, so that, while the engine is running free with the car at rest, it is reduced to half speed, and the explosions are rendered so light and gentle as to be hardly perceptible.

Ordinary street gas is used, condensed to a pressure of 10 atmospheres, and the reservoirs under the floor of the car, which can be filled through a flexible pipe within the time required to change horses, carry gas enough for a run of 8 or 10 miles. The consumption of gas by a loaded car is stated to be 25 cub. ft. per mile, which costs at Croydon 2 cents. The syndicate under whose management the car now in service has been built and tested is naturally disinclined as yet to disclose fully the detailed results, but the editor of *Engineering*, who has been permitted to examine the experiments somewhat carefully, states his conclusions as follows :

"The car is not noticeably different from a horse car. It runs quietly and easily, emitting neither smoke nor steam, and is quite under control. Inside passengers can hear a slight rumble of machinery and perceive a trifling vibration ; but after a minute or two these are unheeded, and practically there is nothing to detract from their comfort. Neither they nor the bystanders in the street can perceive any machinery whatever, for the engine and gearing are entirely inclosed, the motor lying under one seat and the wheels and clutches under the floor of the car. . . . It carries twenty-eight passengers in all, and makes a very fair speed, the limit allowed by the Board of Trade being 8 miles per hour. With the slow gear in action it will readily mount an incline of 1 in 23, with a short piece of 1 in 16, and in coming down it can be stopped by the brakes in its own length. It also goes round a curve of 35 ft. radius on a 1 in 27 grade. Its weight, when filled with passengers, is 5½ tons. For gas it costs 1*d.* (2 cents) per mile, against 3½*d.* (7 cents) per mile for fodder and bedding for horses ; so that the gas-motor car starts with an advantage of 2½*d.* (5 cents) per mile. The performance of the car is quite satisfactory."

The main question, which remains to be decided by prolonged experience, would seem to be that of net cost of maintenance. The initial cost of the motor car is about the same as that of an ordinary horse car, and the eleven horses which are required on well-managed lines to operate it. The point to be determined is, whether it is or is not cheaper to keep one gas engine in order than to keep in health and serviceable condition eleven horses, and whether the machine will last longer in service than the animals. When the motor car is not needed it costs nothing but a shed to shelter it, while the horses must be fed and cared for. From the English standpoint, the horse car is the only system that offers any serious competition with gas, and, as the latter starts with an advantage of 5 cents per mile in the cost of material consumed, its victory on a large majority of the lines in that country would seem to be more than probable.

A special motor car of the type above described, combining all the improvements thus far made and reduced to the utmost limit of simplicity and lightness, is now being constructed in England, to be carried to the United States for exhibition and trial in October. Its performances will doubtless merit the attention of all who are interested in the complicated subject of city and suburban transportation.

QUADRUPLE-EXPANSION ENGINE FOR THIRD-CLASS TORPEDO-BOAT.

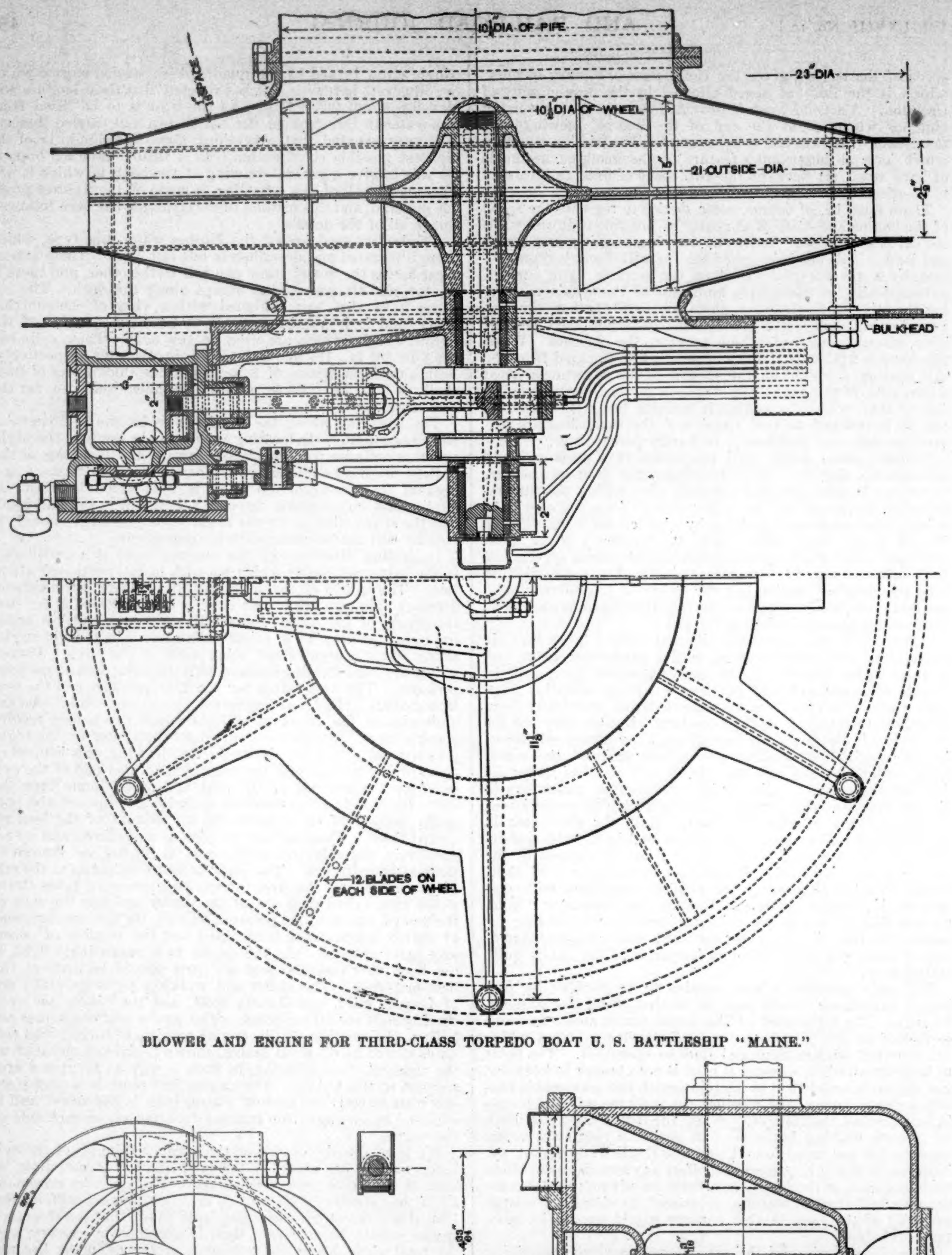
There is being built at the present time at the Brooklyn Navy Yard a third-class torpedo-boat, to be carried on the decks of the United States battle-ship *Maine*. The craft is to be about 65 ft. in length, and is to be fitted and driven by a single screw turned by the quadruple-expansion engine which we illustrate herewith. It is expected that these engines will develop about 200 I.H.P. As the boat is to be lifted from the water to the deck of the battle-ship and carried thereon, it is very essential that everything about her should be of the lightest possible construction. In a future issue we hope to be able to give a general drawing of the boat, in which it will be seen that all of the scantling is made of the lightest possible material, and this method of construction has been followed out in all of the details.

The boilers used are of the Mosher water-tube type, which were illustrated and described in our last issue. These extend clear across the vessel from one rail to the other, and there is no fore-and-aft passageway except along the deck. The engines have also been designed with a view of economizing space, and it is almost startling to note the thinness of the cylinder shells which are used on this boat. These cylinders are 6 in., 8¾ in., 11¾ in., and 15¾ in. in diameter respectively, with a uniform stroke of 8 in., while the thicknesses of their shells is ⅜ in. for the two smaller cylinders and ½ in. for the two larger.

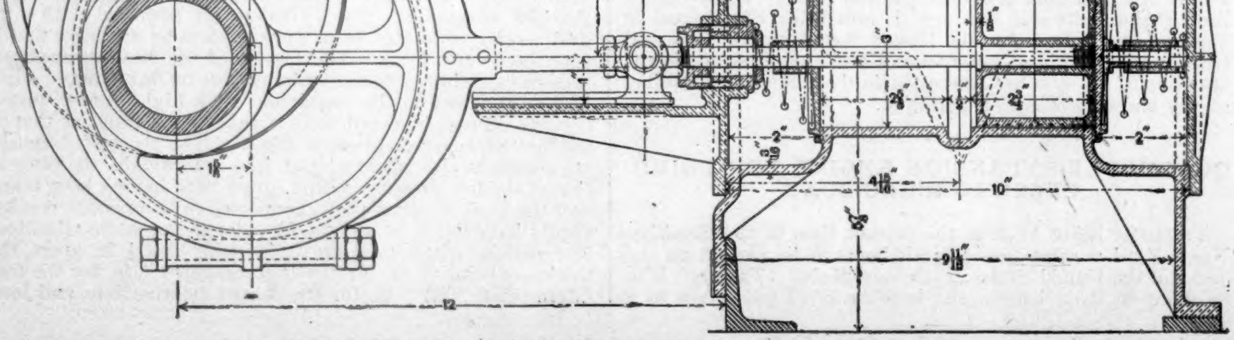
The speed at which the engine is to be run is 675 revolutions per minute. In locating the engine in the boat the high-pressure cylinder will be placed forward and just back of the boilers, allowing sufficient space for the engineer to stand and operate them. Communication is maintained between the engine and boiler-rooms through a hole cut in the bulkhead, and the space allowed for the engineer is just large enough so that he will not be cramped in his movements.

In dealing directly with the engines there is a peculiarity in the valve motions to which we wish to call particular attention. The cranks of the high-pressure and first intermediate-pressure cylinders are placed exactly opposite each other, and the cranks of the second intermediate-pressure and low-pressure cylinders are also opposite each other, but at right angles to the first, the crank-shaft being made of one piece. Piston-valves are used for all cylinders with the exception of the low-pressure. The two valves for the high-pressure and the first intermediate cylinder are operated by the same link. An examination of the drawings will show how this is very readily accomplished. Steam is admitted to the center of the high-pressure valve, and, as shown in the drawing, this is moving upward and has opened the port at the upper end of the cylinder by the amount of the lead, and at the same time the valve for the first intermediate cylinder has opened the port at the bottom of its cylinder by the amount of the lead required there. Thus, as the two pistons move down and up respectively, the valve opens the port at the top and bottom of these same cylinders. The high pressure exhausts at the end of the valve, and the first intermediate pressure takes steam at the end, exhausting out at the center and into the ends of the second intermediate-pressure valve. By this arrangement of valves compactness is obtained and the number of necessary parts reduced. As the engine is so exceedingly light, it has been very essential that all parts should be made of the best materials. The shafts and working parts generally are of forged, mild, open-hearth steel, and the piston and connecting-rods are oil-tempered. The shafts and crank-pins are hollow, the framing of the engine consists of forged steel columns stayed by diagonal braces, shown in the end elevation at the right of the engraving, in such a way as to give a firm support to the guides. The engine bed-plate is a steel plate and rests directly on keelson plates, built in the vessel, and is stiffened by an angle iron running fore and aft on each side of the engine.

We have already alluded to the extreme thinness of the cylinders, which are made of the best quality of cast iron, as hard as could be properly worked. The cylinder covers of all of the cylinders are about $\frac{3}{16}$ in. thick, but are stiffened by ½-in. ribs. Great care has also been taken that the clearance spaces should be no larger than is absolutely necessary, and the total clearance at the two ends of the cylinders has not been allowed to exceed ¼ in., which has been distributed to the best advantage. The cylinders are provided with ½-in. drain cocks, connected so as to be worked by one lever that is near the reverse lever. The pistons of the first intermediate-pressure and low-pressure cylinders are made of forged steel, dished, as shown in the engraving. The high-pressure piston is made of cast iron and weighs exactly the same as that of the first intermediate-pressure piston. The second intermediate piston is also made of cast iron and weighs the same as that of the low-pressure piston, great care having been taken that the reciprocating parts, connected with opposite cranks, should have the same weight in order to lessen the vibration. The packing rings used are $\frac{3}{16}$ in. wide and ¼ in. apart, the thickness being $\frac{3}{16}$ in. for the high-pressure, ¼ in. for the first intermediate, and ⅜ in. for the second intermediate and low-



BLOWER AND ENGINE FOR THIRD-CLASS TORPEDO BOAT U. S. BATTLESHIP "MAINE."



AIR-PUMP FOR THIRD-CLASS TORPEDO BOAT U. S. BATTLESHIP "MAINE."

pressure cylinders. These rings are made of hard cast iron cut obliquely and sprung in without a follower, the joints being placed opposite. Each piston is accurately fitted to the bore of the cylinder, a play of not more than $\frac{1}{100}$ in. being allowed. The mild steel used in the manufacture of the piston-rods and other forged parts has an absolute strength of about 80,000 lbs. to the square inch, with an elongation of 20 per cent. in 2 in.

The main valves for the intermediate-pressure cylinders are packed by one cast-iron ring and follower, as shown, but the high-pressure valve is fitted accurately without rings to the bore of the valve-chamber, which is 3 in. in diameter. The cross-heads are forged with the piston-rods. Each cylinder is carried by four forged steel columns, except over the central bearings, where two columns bear the weight between the two intermediate-pressure cylinders. The bed-plate is of $\frac{1}{4}$-in. steel plate cut away for the swing of the cranks and eccentrics, and stiffened by the angle iron already referred to. The shafts are of forged steel 3 in. external diameter, with an axial hole of $2\frac{1}{4}$ in. diameter, bored through the center. The crank-shaft itself is 7 ft. 11 in. over all, and carries a coupling disk 7 in. in diameter and $\frac{7}{8}$ in. thick, forged solid to the back end of the shaft. This coupling is squared out between the bolts, so that a spanner wrench can be used in turning the engine by hand. The forward end of the shaft projects $9\frac{1}{2}$ in. beyond the forward bearing, and is enlarged at this point to a diameter of $3\frac{1}{2}$ in. for the seating of the eccentrics, from which air-pumps are driven. As will be seen from the engraving, there is a journal on each side of each crank ; this is $3\frac{1}{4}$ in. in diameter by $3\frac{1}{8}$ in. long, except between the two intermediate cylinders, where there is a journal $3\frac{1}{4}$ in. in diameter and $5\frac{1}{8}$ in. long. The crank-pins have a diameter of $3\frac{1}{4}$ in. and a length of $4\frac{3}{8}$ in. for all cylinders, while the cylinder webs are $4\frac{1}{4}$ in. wide by $1\frac{1}{16}$ in. thick.

The propeller is made of manganese bronze, is four-bladed, 36 in. in diameter, with a pitch of 39 in., and a helicoidal area of 4.1 sq. ft. The working parts of the machinery are all fitted with lubricators of sufficient capacity to run for a reasonable length of time. Owing to the high speed at which the engine is to be run, it will be readily understood that it would be impossible to use an oiler while the engine is in motion; thus each cross-head journal take soil from an overhead cup, and each cross-head guide is oiled by pipes leading to about the middle of each forward and backing face. Each eccentric has its oil-cup so arranged that it will be oiled in all positions. An attempt has been made to see to it that, as far as possible, all the oil for the moving parts, except the main bearings, are supplied from one oil-box on the side of the cylinder with the separate valve and cocks for each part to be oiled.

The condenser is of copper No. 16 B. W. G. thick, it is $15\frac{3}{8}$ in. internal diameter and 5 ft. long : the tube sheets are made of composition metal $\frac{5}{8}$ in. thick. It contains 187 seamless-drawn brass tubes $\frac{5}{8}$ in. outside diameter, giving a cooling surface of about 150 sq. ft., measured on the outside of the tubes. The longitudinal seams are brazed. The air-pumps consist of two double-acting horizontal pumps, worked from eccentrics on the forward end of the main shaft. Each cylinder is 3 in. in diameter and has a stroke of $3\frac{1}{4}$ in. Both the cylinders and casings are in one casting. The suction nozzle is at the inboard end of the casing above the cylinders and opens into a suction-chamber formed around the cylinder. In the center of the cylinder there is a slot $\frac{1}{4}$ in. wide extending entirely around the cylinder and connecting it directly with the suction-chamber. The thickness of the piston is such that it will just give a full port opening at each stroke, so that there are no suction-valves, the piston itself taking the place of one. The piston is hollow and is filled with water-excluding material. The external surface is fitted with grooves for water-packing, and is of such a length that it comes about flush with the cylinder end at each stroke. There is a delivery valve for the end of each cylinder. They are flat on the face, and there is no more than $\frac{1}{32}$ in. clearance between them and the end of the piston when the latter is at the end of its stroke ; the inboard valve is guided on the piston-rod, while the outboard is guided by a pin on the cylinder bonnet, as shown ; the valves are kept on their seats by conical springs of phosphor bronze, which are set to produce a pressure of about 7 lbs. The guides for the connection between the eccentrics and the piston-rods are cast on the inboard bonnet. The eccentrics that do the driving have a diameter of $7\frac{1}{4}$ in. and a wearing face of 1 in.

When the plans for this vessel were in preparation, estimates and bids were asked from blower manufacturers for ventilators and blower fans. While many of them could guarantee to fill the requirements for delivery and pressure, the weight they required was so far beyond that which could be allowed, that the department designed the blower which is shown in our engraving. It is driven by a single engine, with a cylinder 2 in. in diameter and a stroke of 2 in. The piston is $\frac{3}{4}$ in. wide, is hollow, is packed by water-rings, and is screwed upon the piston-rod. The valve is a flat D-valve driven by an eccentric. The fan consists of a disk of composition metal, 21 in. outside diameter, and No. 13 B. W. G. On either side of this, blades are attached of the size and shape shown by our engraving. There are 12 of these on each side of the wheel, and they run in a copper casing 23 in. outside diameter. The suction-pipe leading to the fan is $10\frac{1}{4}$ in. in diameter.

This engine and fan has not yet been placed in the vessel, which is incomplete, but shop tests have been made of it at a speed of 2,000 revolutions per minute. Under these conditions it has a delivery of 6,000 cub. ft. of air per minute under a pressure of 3 in. of water.

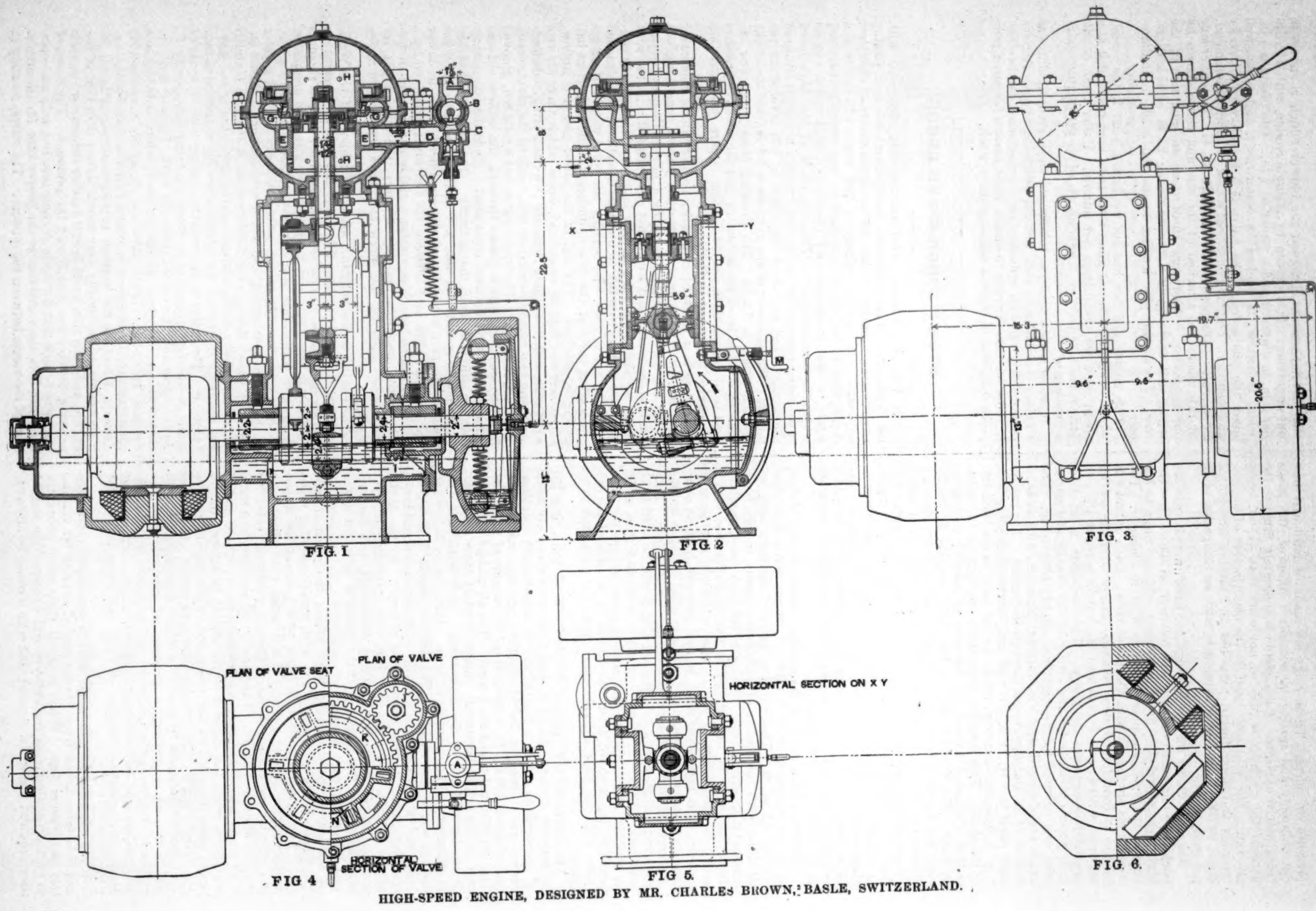
Whether such a vessel as this would show great qualities as a fighter remains to be seen, but the designing of such engines cannot fail to have its influence in showing what can be done to those who are striving to obtain light motors for other purposes than that of marine and stationary work.

BROWN'S HIGH-SPEED ENGINE.

Mr. Charles Brown, who was formerly connected with the Winterthur Works, at Basle, Switzerland, has been paying considerable attention of late to the development of electrical apparatus. In another column of this paper will be found a description of an electric car that he has recently patented, while in this connection we illustrate a high-speed engine which he has designed. This engine is of the high-speed type, being intended to be coupled directly to the armature of the dynamo and to run at the speed of 600 revolutions per minute. The diameter of the cylinder is 5.5 in., and the stroke of each piston is 3.9 in. The drawing from which our engraving is made bears the statement that the effective pressure used is 10 atmospheres, or 150 lbs. per square inch, and that the engine is rated at 16 H.P.

As there is a mark of originality on everything emanating from Mr. Brown, we would naturally expect something out of the ordinary run when he sends a new high-speed engine out into the world, and we are not disappointed. At the very outset we are met with a novelty in the cylinder, which contains two pistons running in opposite directions, and attached to cranks set at 180°. By making the total weight of all reciprocating parts of the two cylinders the same a perfect balancing is obtained. The rod of the lower piston is hollow, and is screwed into its cross-head, upon which there are two wrist pins, and from these there are two connecting-rods leading to the two cranks located on either side of the single crank of the upper piston. The upper piston has a solid rod, grooved for water-packing, which passes through the hollow rod and is made solid with its own cross-head. Even the connecting-rods are different from the ordinary. The single rod of the upper piston spreads out into a Y at its upper end, and takes hold of the two wrist-pins of the cross-head. At the lower end there is a shoe held between the two arms of the rod by a bolt. This shoe has a composition metal bearing on the underside of the crank-pin and is stationary, the adjustment for wear being made by the screw and brass foot shown above the pin.

The engine is single-acting, after the manner of the Westinghouse engine, with the difference that here the pressure is exerted upon both pistons at the same time, and, as steam is admitted to the cylinder at the center, the strain on one piston is upward, while there is a downward thrust upon its mate. If there was a novelty in the cylinders, there is a still greater in the steam distribution and valve arrangement. Steam enters at *A*, passes through the throttle-valve *B*, through *C* and *D* to the belt *E*, extending entirely around the cylinder and having openings shown by the dotted lines up to the valve face below *F*. The valve is an annular casting with a series of stalls *N* (see fig. 4) leading in from the inner passageway *F*. At the upper side the valve carries the teeth of a spur-gear, *K*, that mesh in with those of the pinion *J*, which is keyed to a vertical valve-rod. This valve-rod is given a continuous rotary motion by means of a worm *I* on the main shaft, that drives a wheel on the vertical valve-rod already alluded to. This motion is necessarily very much slower than that of the engine, and even this speed is still further reduced by the ratio existing between the gear *K* and the pinion *J*. The speed of the valve is such that the stalls *N* come into line with and open the ports *G* in the valve-seat at the proper time for the admission of the steam between the pistons. The valve, rotating in



HIGH-SPEED ENGINE, DESIGNED BY MR. CHARLES BROWN, BASLE, SWITZERLAND.

one direction, is an admission valve only. The exhaust is obtained by giving the pistons such a stroke that at the extreme outer ends the ports *H H* at the upper and lower ends of the cylinder are uncovered, allowing the steam to exhaust into the chamber formed by the spherical casing, from which it escapes to the atmosphere or condenser through the 2-in. pipe at the left of fig. 2, as indicated by the arrow.

The regulation of the speed is obtained by means of a throttling governor, the construction of whose valve *C* and other details is very clearly shown by fig. 1. The fly-wheel carries a pair of bell-cranks, on the short arms of which are the weights. As they move outward under the influence of centrifugal force the long arms are drawn in, acting, in turn, upon the exterior bell-crank in a manner that is very readily traced through to the valve by reference to the engraving.

The similarity to the Westinghouse engine once more appears in the dipping of the cranks into the oil-well at the bottom of the frame at every revolution. The cellar is closed by a tight door shown at the right of fig. 2. This door is kept to place by the hinged lever *L*, against which a screw is forced by the small crank *M*. The fly-wheel also carries oil in the bottom of its interior, as shown, by which the moving parts of the governor are thoroughly lubricated.

One feature of the engine will commend itself to all mechanics, and that is the accessibility of all parts for easy inspection and repairs. The governor is open to inspection and adjustment at all times; by draining the oil cellar the door can be opened by a few turns of the handle *M*, and the bearings of the cross-head reached. The cross-heads are free at all times, and the valve is accessible after the removal of the hemispherical casing. We have as yet received no record of the work done by the engine. As for repairs, it would seem that the principal point to be looked to in order to keep these down would be the securing of a proper lubrication for the valve.

CENTRIFUGAL PUMPS.*

By John Richards.

(*Continued from page* 418.)

II.—History of Centrifugal Pumps.

I presume each prominent nation in Europe considers the invention of centrifugal pumps as belonging to their people, and it was a matter of no concern until the method came to be applied to useful purposes, and took its place as a manufacture, but there is scarcely a doubt that the first organized centrifugal pump was invented by Denis Papin, about 200 years ago, in Hesse, Germany, where it was called the "Hessian suck." This pump of the celebrated Frenchman, of which there are drawings in existence, was by no means a bad one, and in all essential features, except a volute casing, corresponded to the construction afterward adopted in this country in 1818.

The celebrated Dutch engineer Huet says that Perreboom introduced the horizontal centrifugal pumps in Holland in the first years of the nineteenth century; but as no precise date or examples are named, some allowance can be made for Huet's evident prejudice against centrifugal pumping, because he instantly follows this remark with the statement that 30 years later Lipkens made his celebrated single-acting pump for draining Haarlem Lake. Huet's work, "Stoombemaling Van Polders and en Boczems," 1885, gives scant mention of centrifugal pumping, although at that time such pumps might be said to have supplanted to a great extent the old cumbrous Dutch pumps in Holland, as elsewhere.

Another of the oldest drawings, extant at this time, is that of Le Demours, a Frenchman, dating from 1732. It is a kind of "Barker mill" machine, and the forerunner of various other pumps on the same principle, that of Barker's mill inverted, which have been periodically invented ever since—one within the writer's knowledge a few years ago here in California. The same invention, or "mode of operating," is said to have been discovered in connection with reaction water wheels by their overrunning and drawing the water from the chute or inlet after the gates were shut.

Mr. Whitelaw, an inventor of reaction water wheels in their common or applied form, himself converted the method to pumping by centrifugal force, and made pumps of the submerged type that gave some very good results, which were fortunately tabulated in a careful manner in 1849, at Johnstone, near Glasgow. These tables contained factors for friction of both water and machinery, with exact measure of resistance and power, that would do credit to a scientific commission of our day. The tables will be given in another place. Whitelaw's pumps were first made about the year 1848.

* Copyrighted, 1894.

To begin at the true beginning, when centrifugal pumps first took practical and useful form, we have to, as before claimed, come to the United States.

It is a commonly entertained opinion in this country that centrifugal pumps were invented and first applied in Europe, and the art, to so call it, is one in which American engineers and mechanics had but little part down to recent years. This opinion being, inferentially at least, promulgated by some recent articles on the subject (1886), has prompted the writer to carry out a long-intended purpose of giving some history of this important manufacture, and establish, as far as ascertainable facts will serve, the part that has been contributed from the United States.

It will, no doubt, be a matter of surprise to most of our readers to know that centrifugal pumps as practical operative machines are strictly and entirely an *American invention*, and that 20 years before such pumps were made or known in Europe they had in this country attained a form and efficiency but little inferior to the best practice of the present day, and in some respects superior to pumps that are now made and sold. This matter will, in a future place, be explained, and drawings given of American centrifugal pumps made between 1818 and 1830, long before any such manufacture was thought of in England, or on the continent of Europe.

THE MASSACHUSETTS PUMP.

A pump embodying almost every essential feature of modern practice was invented in Massachusetts in 1818, 30 years before the same thing was applied in Europe, and 40 years before there was a modification there that can be called an improvement.

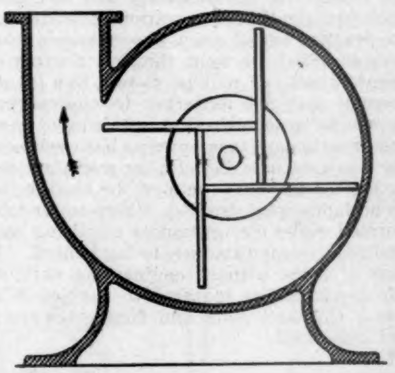


Fig. 13.

THE MASSACHUSETTS PUMP.

The drawing (fig. 13) is a section through what was called the Massachusetts pump of 1818. It, as can be seen at a glance, is the "parent of its tribe," the completed machine, and in useful effect would equal, if not excel, either of the modifications exhibited at London in 1851, 33 years later. It is proposed, however, in the present chapter to deal with the chronological part of the subject, and discuss separately the merits and constructive features of the different pumps.

The Massachusetts pump fell on barren ground. There was at the time but little use in the United States for such pumps, and but scant means of communicating inventions over the country. There was land enough without draining it, and water-raising except from wells was exceptionally required. We, however, hear of the Massachusetts pump finding its way to New York in 1830, and being exhibited there with very satisfactory working results, guessed at then no doubt, but ascertainable even now if it were worth the trouble.

The casing was of rectangular section, beveled from the center to the periphery, but not in a degree to conform to volume and velocity, as a theoretical pump of our day would be, but an approximation that showed the inventor had an inception of the true working conditions.

The first pumps were made to operate under water, like those of Bessemer; and I conjecture the improvements mentioned in connection with the exhibition at New York in 1830 to be the addition of side suction pipes, because the pumps were exhibited in public, which could not well have been done if they were submerged.

GWYNNE'S CENTRIFUGAL PUMPS.

The Gwynne pumps, referred to in the writings before named, are of American origin. They were at first an attempted and doubtful improvement on American methods well known and successfully applied at the time; not only this, the first experiments of Mr. J. S. Gwynne, the senior brother among those of the name now comprising the firm of Gwynne & Co., and J. & H. Gwynne, of London, England, were made in Pittsburgh, Pa., in 1844. The first pump made by Mr. Gwynne was for the Passaic copper mine, in New Jersey, the location of which I am unable to ascertain at this time.

Mr. Gwynne's first patent was taken out in the United States, from New York, where he then resided, and where he continued to reside for some years after the great contest and controversy with Appold at the London Exhibition of 1851, when such pumps were for the first time publicly exhibited in Europe.

The pumps shown there by Mr. Gwynne were called "Gwynne's American Pumps," and it was, no doubt, in some measure, due to this fact that the controversy arose between he, Easton & Amos—now Easton & Anderson, who exhibited the Appold pumps—also with the makers of what is called the Bessemer pump, as will be hereafter explained.

I think the term "Gwynne's American Pump" was hardly correct, because Mr. Gwynne's alleged improvements on the American pumps, as before intimated, were of questionable value, as he would no doubt now admit; at least they form no part of his present practice, and, as a matter that need not be one of opinion wholly, I will venture to claim that had the centrifugal pumps as made in America previous to Mr. Gwynne's improvements been put in competition at the exhibition of 1851 they would have given much better results than either of the three that were exhibited there.

The drawings to be given hereafter will prove this, because, in the light of modern experience, the duty of a pump of this kind can be very fairly ascertained from its construction.

The experience of Mr. Gwynne in the United States during a term of 10 years or more was, in a sense, the foundation of the manufacture that bears his and his brother's names. This manufacture, which is one of the greatest facts in the recent history of centrifugal pumps, was but a continuance of the art transplanted from America, and for a long time without substantial improvement except in workmanship and strength. It will not be too much to claim that after various experiments and modifications the practice *settled down to very nearly what it was in this country in* 1830. It went through a cycle of change and experiment, which, as will be shown in a future place, was alike unusual and not flattering to engineering skill of 40 years ago—not to be wondered at in this case, however, because the construction of these pumps has even now scarcely settled down into a regular engineering manufacture.

The comparatively limited use for pumps of the kind in the United States, where no lands were drained, where water-raising was seldom performed under circumstances requiring centrifugal pumps, permitted this manufacture to lag behind. It also fell into the hands of firms without engineering skill, or without the skill and opportunities required to develop it as the firms of Gwynne & Co., and John and Henry Gwynne, have done in England since 1855.

The works of Gwynne & Co. were situated at the water side, just south of the Temple in London. The ground on which these works stood was acquired by the Commissioners for the Victoria Embankment, and the works were moved back to a position almost opposite the Temple Station of the Metropolitan & District Railway.

The works of John and Henry Gwynne are at Hammersmith, 8 or 10 miles westward on the Thames, and among the engineering manufactures of England it is to be questioned whether, on the grounds of careful workmanship, the selection of material, or general good quality, there is any branch more carefully conducted.

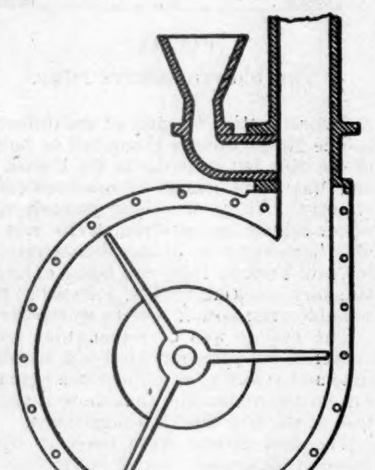


Fig. 14.

EARLY GWYNNE PUMP.

The pumps, as before claimed, have gone through a maze of modification both in England and on the Continent. There has been retrogression as well as advance, and, except in the case of Messrs. Gwynne and some other firms that follow them, there is not much beyond the American practice of 50 years ago.

Mr. Gwynne, in his patent of 1851 in the United States, begins his claims by saying, "I do not claim to be the inventor of centrifugal pumps," and after other negation to qualify his discoveries, confines his positive claims to certain mechanical details, which, as before remarked, have long ago disappeared in his own practice, and, so far as I know, never had place in any machines except those made soon after 1850. The pump for the Passaic copper mine was, we may infer, in its main features, similar in construction to those exhibited in London in 1851.

This latter was an encased impeller pump with an arrangement to protect the back of the disk from pressure, there being a single inlet at one side. It was carefully engraved at the time, and can be examined in the patent and other references now available. It was called "Gwynne's Direct-Acting, Balanced-Pressure Centrifugal Pump," and called also, as before mentioned, "Gwynne's American Pump." It is shown in fig. 14.

BESSEMER CENTRIFUGAL PUMP.

Messrs. Gwynne, Appold, and Bessemer were exhibitors of rival pumps at the exhibition of 1851, and out of a controversy that arose there we are indebted for some history of American pumps that would otherwise no doubt be lost. Our meager records of that time, and a period of no record of inventions to speak of, from 1818–47, has left us without history of early practice in this country, but in order to combat some of the claims made by Mr. Bessemer (now Sir Henry) Mr. Gwynne and his friends were obliged to bring forward accounts and descriptions of the American pumps that formed the basis of Mr. Gwynne's practice. This, however unwillingly it were done, was unavoidable, because Mr. Bessemer had attached to his pump at the exhibition a placard bearing the following inscription:

"This model of a centrifugal pump for forcing fluids is made in rigid accordance with the specification of Mr. Bessemer's patent, dated December 5, 1845, being the first recorded invention for impelling fluids by centrifugal force by a revolving disk."

This pretentious claim will appear a little ridiculous in the light of the facts, unless the word "recorded" is employed as a qualification; at any rate, it gave offense to Messrs. Gwynne and Appold, and, as before remarked, caused a controversy between the commissioners and jurors of the exhibition as well as exhibitors.

No doubt Mr. Bessemer had made an original invention so far as he was concerned, and discovered the employment of centrifugal force for "impelling fluids." He was, in fact, engaged in making centrifugal drying machines for sugar, and, no doubt, at the time had more to do with centrifugal apparatus as an element in machine construction than any engineer then living. His pumps as then made, subsequently improved and patented again in 1849, bear in many respects close analogy to centrifugal drying machines. One idea was born of the other, or, as might be said, one idea is almost the same as the other, and it would be quite unfair at this time to detract from the importance of Bessemer's invention, however much we may differ from the particular methods of application and use.

The adaptations shown in his elaborate patent of 1849 exhibit a fertility of experience and acquaintance with constructive mechanics that remains remarkable even to this time.

The controversy mentioned culminated in a challenge from Mr. Gwynne to operate the pumps in competition for a year, the losing competitor to pay £1000 into the treasury of the London Mechanics' Institution. This challenge was not accepted.

REPORT OF THE UNITED STATES COMMISSION AT VIENNA.

A claim to original discovery of particular inventions on national grounds is in many cases silly and provincial, but in the present is so marked and has been so ignored that its review will be a matter of common fairness, especially as common opinion in the matter is to some extent based on the report of the American Expert Commission sent to the Vienna Exposition in 1873. To this report is due, unfortunately, in a great measure the idea of centrifugal pumps being of European origin. This report is a remarkable one, not only in a distortion of facts, but in the ignorance of hydrodynamics which it presents.

Without wasting space to quote further from this report, the following salient points appear (see pages 193 *et seq.*):

"(1) Appold was the introducer of this class of pumps; (2) they are misnamed centrifugal, because they do not operate by centrifugal force at all; (3) they operate by pressure the same as a turbine water wheel; (4) when people understand their method of operating we may expect much improvement; (5) they should have disk runners, because the fan wheels will soon wear out."

This much, I think, will do. This extraordinary report stands printed in a Government publication, signed by men who were, or are, eminent in mechanics, and we can only deplore the stupidity as well as presumption of the commission who thus disposed of a subject that had twenty years before been carefully investigated by such men as Sir John Rennie, Professor Cowper, Mr. Whitelaw, Dr. James Black, Professor Rankine, and many others. The most astonishing part is, however, that this report was passed and signed by men who we can hardly suppose would fail to perceive its absurdity.

BLAKE'S PUMP.

Returning again to American pumps, in 1831 Messrs. Blake, of the New Steam Mills, in Connecticut, invented one, shown in fig. 15, and well worthy of attention here as being the first of its type, and almost identical with Bessemer's of 1845 and 1849. It is, in fact, the better machine if carefully compared, but subject, like nearly all disk pumps, to lateral thrust upon the impeller that would cause difficulty in working.

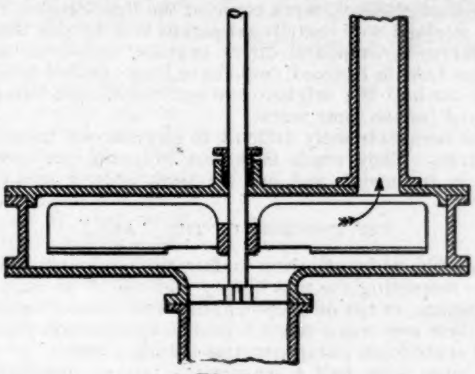


Fig. 15.

It was in every sense a "departure," and is by no means obsolete at this day for high lifts. The force of the issuing water, or its tangential energy, is lost, as may be seen by the annular casing and change of the water's course, but this loss has to be measured by the relative speed between the wheel and off-flowing water, as has been explained. This invention has of right a prominent place in the history of centrifugal pumps.

ANDREWS' PUMP.

The next American pump to follow was that of Andrews, invented or published in 1839, the first American pump with a cylindrical discharge chamber. If the Massachusetts pump came near anticipating our best modern practice, the Andrews pump completed the matter, and leaves room for the lament of Lord Byron that "those thieving ancients have stolen all of our modern ideas."

The construction, in side view, is identical with the Massachusetts pump invented in 1818, and shown in fig. 13, the difference not demanding a new drawing; Andrews' invention relating to a cylindrical chamber at the vane tips. Excepting the straight vanes and one or two less important points, the pump is capable of high duty, and conforms very nearly to good modern practice for dredging purposes.

The effect of curved vanes, as has been explained, is dependent on speed or pressure, and is not a qualifying factor of the pump's duty unless pressure be included, and it is safe to claim that for low heads this American pump of 1839, made long before any such machine was known in Europe, is capable of a duty within 10 per cent. of the best modern performance, and its only distinguishing feature, comparing with its predecessor, the Massachusetts pump of 1830, is a casing of cylindrical section not differing at all from the patterns in use at the present time by several makers in the Eastern States.

The transverse section of the pump would show the "waterway" diminished from the inlet to the periphery to conform as nearly as practicable to volume and velocity; in fact it was in this respect much better proportioned than many pumps now being made and sold. This pump, let it be remembered, was produced and publicly known five years before Mr. Gwynne's experiments at Pittsburg, and at a time and place that leaves only the Massachusetts pump as a possible precedent.

We must not, however, detract from the last-named pump further than to call Andrews' an improvement. It is a step further in the art, and a very possible invention that any one might make, and, no doubt, a result of improvement in mechanical facilities for making the casing of two pieces of cast iron, and the water duct of cylindrical section.

WHITELAW'S PUMP.

This brings us down to the time of Whitelaw's experiments at Johnstone, near Glasgow, in Scotland. The exact time is not known, but it was between 1847 and 1849. Mr. Whitelaw was the inventor of a water wheel that bears his name, and his pumps, which he describes as "especially suited for draining lands," are in most respects an "inversion" of his water wheels.

Fig. 16 will give an idea of the arrangement, which differs but little from pumps erected within a few years past by thorough engineering firms in England, and also of some made from the writer's designs now in use in California.

The most remarkable feature of Mr. Whitelaw's experiments is the very complete knowledge of hydrodynamics they show. The following are four out of nine columns in tables he prepared from experiments to determine the efficiency attained by his pumps:

No. of Experiments.	Revolutions of the Pump.	Loss by Friction and other Resistance in the Pump.	Loss by Force of Water after Leaving the Pump.	Efficiency. Power of Pump Motor being 100.
1	327.6	19.370	7.314	69.23
2	278.4	12.780	9.462	73.18
3	226.8	7.027	13.980	79.67
4	199.0	4.466	18.620	75.78
5	182.0	2.984	23.780	76.48

The power was measured by a dynamometer of delicate construction, and the experiments in every way conclusive. The formulæ employed in his computations can be found in the *Practical Mechanics' Magazine* of 1850.

There is an erroneous opinion existing respecting the efficiency of pumps of this kind, of which more will be said hereafter; at present I will, however, point out that the effect produced by Mr. Whitelaw with his submerged wheel was 7 per cent. better than anything attained in the exhibition of 1867, and might have been much more if the up-take had been an annulus—that is, the main casing filled in, so the discharge energy would not have been lost in the large body of nearly still water above the wheel.

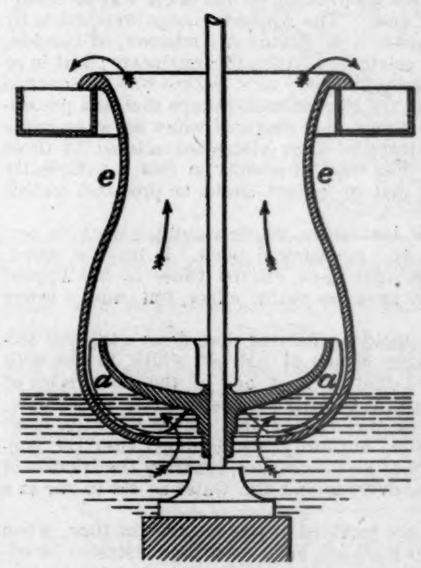


Fig. 16.

The next stage in centrifugal-pump history includes the experiments of Messrs. Gwynne, Appold and Bessemer, of which some account has already been given.

The pumps produced by Gwynne we can presume to be the same, or analogous to, the one patented in 1850, and shown in fig. 14. This pump affords room for extended comment, which must, however, be passed over here. It was the one shown in competition with the Bessemer and Appold pumps at the exhibition, and by no means so good a one as its predecessors in America, although more expensive and complicated. In support of this opinion I have only to refer to Messrs. Gwynnes' modern practice. The discharge chamber was annular, as shown in the side view.

BESSEMER'S CENTRIFUGAL PUMP.

In 1845 Henry Bessemer, now Sir Henry, invented and patented his centrifugal machine or pump, before referred to.

It is not necessary to give drawings of this machine. It had simply an encased impeller, or "runner," as we now say in this country, revolving in a free chamber or casing, the discharge or tangential force of the water being neutralized and lost in the surrounding body or stratum. The writer has rea-

son to understand these pumps, having himself gone through perhaps the same chain of experiments and reasoning 40 years later, but with a different result. The principle or method of operating was found applicable to high heads or high pressure, the loss of power being to a great extent compensated in other ways.

The pumps of Mr. Bessemer constituted a kind of "roundabout" way of attaining a simple result, and contained some kind of a pneumatic attachment that we need not now trouble ourselves to even inquire about, and much less to describe. The pump, aside from its last-named feature, which was no essential part of it, had been not only anticipated, but exceeded by Blake's of 1831, shown in fig. 15, which was a better and more simple machine, embodying all the operating features of its pretentious successor of 14 years later.

I am not at all astonished at Mr. Gwynne's resentment respecting the Bessemer pump, or the Appold pump of Easton & Anderson. Both of them were, in a sense, "upstarts," as their subsequent history has proved. We must, however, concede to Mr. Bessemer, and no doubt to Easton & Anderson also, that they were not aware of what had been done in this country more than 30 years before.

In 1846, after the Andrews pump had been applied to a great variety of purposes in this country, it was improved and again patented both here and in England, Messrs. Gwynne & Co. acquiring the right for that country.

At this date we find the encased or closed impeller so nearly conforming to the present form that its invention may with all fairness be ascribed to Mr. Andrews, and claimed for this country. This has been conceded by impartial English authority of 6 years later, and adds another to the claims that can be made in respect to the origin of centrifugal pumps in the United States.

In the same year (1846) Messrs. Von Schmidt, of New York, patented in this country a new modification of centrifugal pumps, an adaptation or change of the Andrews pump, but having no claims beyond its early date that need receive attention here. A glance at the drawings of the Von Schmidt pump will show that the theory of their action was not very well understood.

THE APPOLD PUMP.

In 1848, 2 years later, we come to the celebrated Appold pump, and the first comment must be that there was no reason for celebrity in the case. The Appold pumps were made by Messrs. Easton & Amos, now Easton & Anderson, of London, then and now very celebrated hydraulic engineers; but in so far as Appold's pump the only new feature was the curved blades conforming to the Barker mill pumps that had preceded. Appold's first pumps had diagonal vanes set at an angle of 45° from a diametrical line, afterward altered to those curved backward. The want of novelty in this is sufficiently proved by the fact that no patent could be procured on this alleged invention.

In some cases for low heads, where a pump's work is performed by impact, or "mechanical push," it may be called, more than by centrifugal force, curved vanes of the Appold form would not only have no useful effect, but cause a lower efficiency.

The change of Appold's wheel or disk from a tapered section, with a discharge orifice of narrow width, to one with parallel sides, shows that at least one of the main laws of hydraulics, a change of velocity without change of volume, was not known or else was disregarded. Even recently, however, one mathematical authority has assumed that the converging wheels were of no importance, ignoring the friction of the broad vane tips, overrunning the water as six to one at a head of 40 ft.

On the whole we are justified at this distance of time, when the merits of various methods have been demonstrated by experience, in concluding, as before intimated, that the reputation of the makers and the contest at the London Exhibition of 1851 did more to make the Appold pump known than its working merits.

Subsequent tests, notably one at the Chatham Dockyard, in England, and one at Trafalgar Square, London, showed that however important the curved vanes might be, other features of the pump were bad or wanting. Messrs. Easton & Anderson have, however, constructed some of the best and most efficient centrifugal plants known.

The fact is that the controversy of 1851, so often mentioned here, removed the pump matter from the field of engineering investigation to one of commercial contention. In respect to vanes, for example, there were at the time in England plenty of engineers and scientific men who could have developed from mathematical data the true and best form for pump vanes at different heads.

It is true Professor Rankine defined a form of vanes which did not give a good result under certain circumstances. I am speaking from memory, not having seen the drawings for some years past, but, as now remembered, Rankine's proposed vanes were suited for low heads only, and, no doubt, his computations were correct, as all must be if the premises are not mistaken; I may also remark, in respect to Appold's wheels, that computation would not in any case have produced vanes of a true curve such as are shown in drawings of his pumps made at the time.

Bessemer's second patent of 1849, a treatise it might be called on the general and special adaptations of Mr. Bessemer's pumps to various purposes, is an interesting study at this day. His pumps, as before remarked, can be explained by referring to Blake's pump, fig. 15, which is typical of all the modifications in Bessemer's patent of 1849, and already sufficiently discussed. Then followed Gwynne's improved pumps, and to Messrs. Gwynnes' credit be it said, the workmanship on centrifugal pumps and the engines to operate them reached in the hands of this firm a perfection that perhaps no other branch of similar engineering work could at the time excel. The efficiency attained with centrifugal pumps was, by this time, such that Harvey's compound direct engines, employed to drain Haarlem Lake in Holland, could have been excelled in performance at one-half the original cost had centrifugal pumps been employed for the same work.

It has been extremely difficult to ascertain the dates heretofore given. They reach back but 76 years, but have been found in fragments, and are far from orderly arrangement here.

THE PROGRESS OF THE "ART."

It is, perhaps, in all cases unfair to indulge in censorious opinion respecting the past history and rise of an engineering manufacture, or the development of a new class of machinery, but if there ever was a case where such opinion was justifiable, that of centrifugal-pump progress is such a case.

For more than half a century the pumps remained practically where they began. "The last was like unto the first," and during this period there was mistake, retrogression and a failure to discern simple elementary principles that surpasses present belief.

To prove this, one has only to compare the first American pumps of 1818 with those now made in this country, and by Gwynne, Allen, Drysdale and others in Europe at the present day. This is enough to show how little has been changed or improved, but it fails to in any degree indicate the practice that has intervened.

The dynamical laws or principles involved in the operation of centrifugal pumping seem to present but little of the complicity attendant on heat engines, or in dealing with expansive gases. The problem is simple in comparison with the mathematics of projectiles, of turbine water wheels, or a dozen other things that might be mentioned, that have arisen and been disposed of during the time.

Centrifugal pumps have gone through a development of experiment by mechanical expedients, a method generally slow and uncertain, not wholly so, however, because in 1848 we find Mr. Whitelaw making computations involving all the principal conditions of centrifugal pumping. Still further on, however, we find the celebrated Mr. Rankine suggesting curves for the vanes of such pumps, at variance with the almost universal Appold form.

Encased impellers have been one of the stumbling-blocks over which nearly all pump-makers have made their way. Blake, Gwynne and Andrews in America, and Bessemer in England, have all contributed to this error, if error it be, and within a few years past the same old round has been gone over again by a firm in Massachusetts that adopted the Gwynne pump in other respects, but at first employed a Bessemer or Andrews impeller. In a recent number of the *Engineer*, London, appears in an advertisement various sizes and adaptations of centrifugal pumps, all constructed with encased impellers. The writer and some other makers in California followed the same course, and, as before remarked, this thing has been taken up and at some time abandoned by nearly all prominent makers of centrifugal pumps.

The causes for this are not difficult to trace. There has always been a desire, for commercial and other reasons, to employ a single inlet at one side of the pumps. This simplifies the construction, saves a great deal in first cost, makes the water-ducts more direct and free, and all parts more accessible. To accommodate this construction, seen in Mr. Gwynne's pump of 1850, there was difficulty in balancing the inclosed wheel—that is, compensating for the draft on the inlet side.

Open vanes, like those in the Andrews pump of 1839, avoid the thrust, but such vanes to be made of cast material require

a web or diaphragm to support them, and as soon as this was introduced the thrust became destructive, not only equaling the indraft or suction, but the whole area of the back of the disk or diaphragm became subject to a pressure equal to that in the discharge pipe.

There is a recognition of this difficulty by Mr. J. S. Gwynne in 1850, and his ingenious attempt to balance inclosed impellers by a vacuum or free space at the back. This is very complimentary to his engineering insight at the time, and it is a question now whether there is any true understanding among engineers of the function to be performed by the balancing chamber described in his patent of 1851. It seems to be a vacuum chamber to balance the draft of the suction, but is, in fact, to protect that much of the area of the back of the impeller from the pressure within the casing.

This subject was discussed in a paper read before the British Association, at Norwich, England, in 1868, by John and Henry Gwynne, and, since that time at least, open impellers have been a constant feature of their practice, and is no more than a return to the principle of the Massachusetts and Andrews pumps of 40 years before.

The adoption of open wheels or impellers, it was supposed, called for a double or balanced suction, as the single inlet forced the employment of an inclosed or double-disk runner. It was a cycle of experiment running over a period of 40 years, and ending where it began, if we do not include the form of the vanes.

Nothing has been said of French practice, and the writer must confess to some prejudice in the matter, because of certain reports about the year 1866, when there was a competitive test of some Gwynne pumps with those made by M. Coignard, of Paris. The Gwynne pumps were set down as working at a duty of 35 per cent., while the Coignard pumps realized nearly double the same effect. Looking at the construction in the two cases, and making such deductions as a fair inference would afford, we must conclude the report was of no value, and its statements impossible. Since then M. Farcot, of Paris, has produced some fine examples of centrifugal pumps for various purposes, some of them to operate against a head of 30 meters, and large pumps of excellent design, such as have been erected on the river Nile in Egypt.

French engineers have developed a good deal in compounding pumps, and, I believe, first invented the double or multiple impellers, one discharging into another, to be used in the case of high heads. I am not sure, however, whether Mr. Gwynne's compound pumps were first proposed or not. It is not a matter of much importance either way, because, all things considered, it is doubtful whether compounding is a construction to be recommended beyond certain exceptional cases. The problem involves questions not answerable by computation. It is one of mechanism and endurance, which future experience must determine, so that if added by our French friends to modern pump practice it must stand as a feature of questionable value.

While, as pointed out in the beginning, the invention of practical centrifugal pumps belongs in America, their development and application in an extensive way was for a long time mainly the work of English engineers. The draining of marsh and overflowed lands, and for graving docks, are the principal purposes to which the larger class of centrifugal pumps are applied, and neither of these wants had, down to 10 years ago, existed to any extent in the United States.

The draining, irrigation and reclamation of land, while it is to some extent owing to the physical circumstances of a country, is mainly a matter of the value of land and its scarcity. In some cases, as in California, to great fertility, but except on the Pacific Coast there has been until very recently no need of water-raising for these purposes, at least not enough to cause, as in Europe, a complete development of the most suitable machinery for the purpose.

At present there is a change going on. The cultivation of rice in the Southern States, and of cranberries and some other crops in the Northern States, the enhanced value of marsh land near large cities, and the greatly increased value of alluvial plains, begin to call for the development and improvement of water-raising appliances.—*Industry.*

(TO BE CONTINUED.)

MAP OF ELECTRIC RAILWAY FROM GETTYSBURG TO BALTIMORE.

ELECTRIC RAILROAD FROM GETTYSBURG TO BALTIMORE.

THE sketch map herewith shows the location of an electric railroad which is intended to connect the now historic Gettysburg with Baltimore. To those unfamiliar with this section of country it should be said that most of the southern portion of Pennsylvania, indicated on the map, and a considerable part of Maryland lying between it and Baltimore, is very rich farming land, and is thickly settled. In the pre-railroad period, early in this century, turnpike roads were built through this region to Baltimore, and the produce in the section shown on our map and from far beyond it was hauled to Baltimore on what were known as Conestoga wagons, which were drawn by four, six, and sometimes eight horses. The writer recalls that in his schoolboy days these wagons passing through his native place—which was Hanover, and is indicated on the map—were a daily sight, passing up and down on the turnpike, shown by dotted lines. This road extended

from Hanover to Reisterstown, and also extended northward to Carlisle and Harrisburg, and connected with the whole system of turnpikes in Pennsylvania. Another similar road connected Gettysburg with Reisterstown, and from there a single line led to Baltimore. The amount of traffic on these roads, up to the fifties and sixties, was very large. After that period it was diverted to the railroads. The relation which Baltimore occupied to this country is very naïvely stated in Peter Parley's "First Book of History," published in the thirties. In that book the amiable historian said: "After seeing the rest of the city" (Baltimore) "you should go to Howard Street, where you will notice a great many wagons loaded with flour. Baltimore is the greatest flour market in the world. Thousands and thousands of barrels are brought here every year from various parts of Maryland, and from Delaware, Pennsylvania and Virginia. It is then sent in ships to New York, Boston, Charleston and various foreign countries."

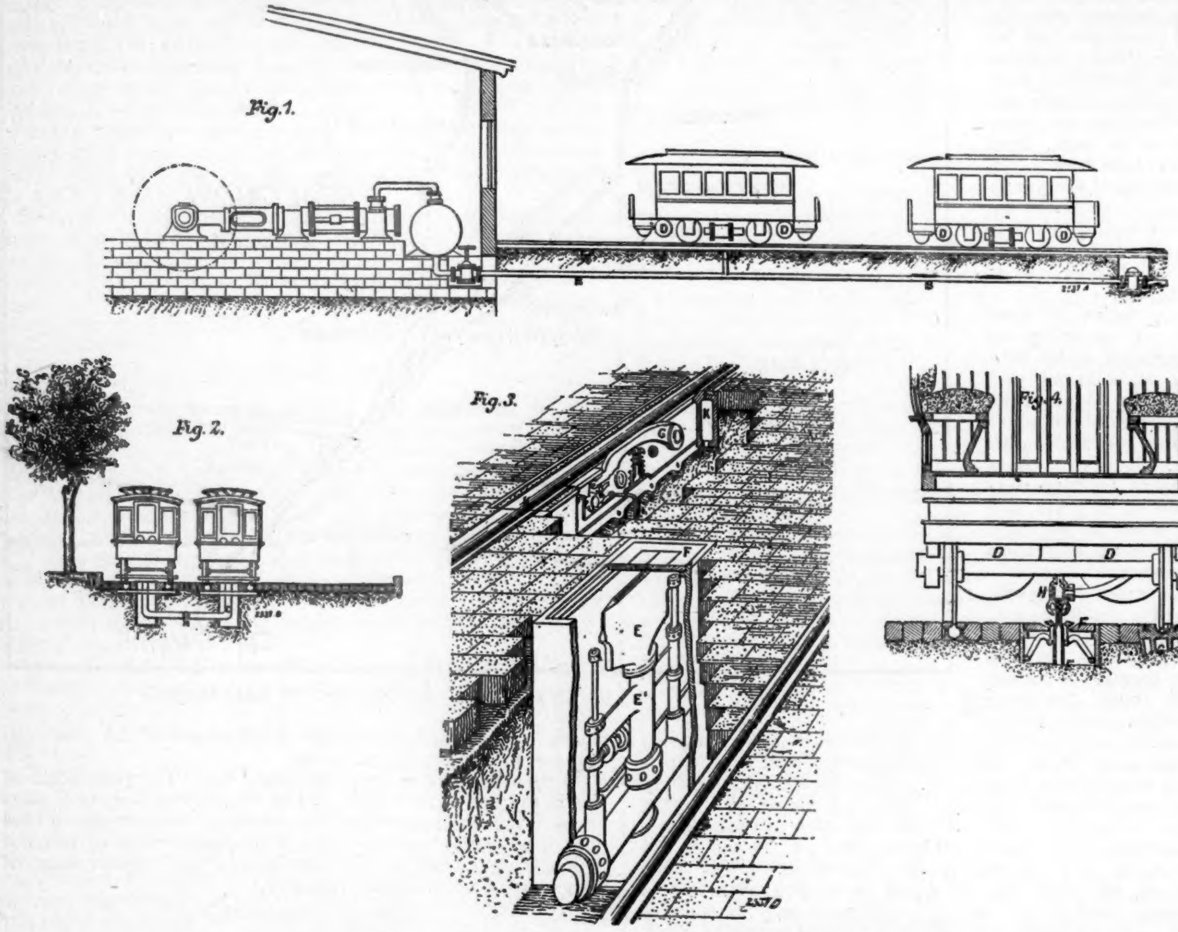
As remarked above, this trade was diverted from the turnpike roads to the railroads. An effort is about to be made to get some of it back. The present turnpike between Gettysburg and Baltimore, as explained, is shown by the heavy black line in the map. This, as will be seen, is nearly an air line between the termini; and this road is to be used in carrying out the project on account of its straightness and because of the many towns, large and small, that have grown up along it. The distance from Baltimore to Gettysburg by the proposed route is 50 miles, as against 72 miles by the steam railroads.

The parts of the line to be provided by different companies are: The Pimlico & Pikesville Line, 7 miles, opened in 1892 from Druid Hill Park, Baltimore, to Pikesville; the Pikesville, Reisterstown & Emory Grove Railway, 9 miles, from Pikesville to Reisterstown, with an extension of 1¼ miles to Emory Grove camp grounds. Contracts for this road were awarded last week.

The power house will be located at Owing's Mills; the Westminster & Union Mills Railway, 17 miles, from Reisterstown through Westminster to Union Mills; the Gettysburg Electric Line, 17 miles, from Union Mills through Littlestown, Pa., to Gettysburg. Several miles of this line are now built south from Gettysburg across the famous battle-field. This new line will afford excellent facilities to the many strangers and foreigners who annually visit the battle-field, and will be the means of bringing the territory between Westminster and Gettysburg into direct communication with Baltimore. The present means of reaching these points from Baltimore are by the turnpikes which form the route of electric lines, or by the Baltimore & Hanover, Hanover Junction, Hanover & Gettysburg steam railroads, which are controlled by the Western Maryland Railroad Company.

Owing's Mills, where the power house is to be located, was for many years connected with the Northern Central Railroad, which is located east of it by the Green Spring Branch—shown on the map. This was originally laid with old strap rails, and for a long time was operated by horses. The writer can recall a journey on this road in the fifties on the top of a four-wheeled coach-body car similar to those which were duplicates of the old cars used on the Mohawk & Hudson Railroad, and which were exhibited at Chicago last year. The motive power on the Green Spring Branch was a faithful mule.

New York and Philadelphia capitalists are said to be large holders of the bonds, and it is believed that the Widener-Elkins syndicate holds an interest in it.



METHODS OF DISTRIBUTING COMPRESSED AIR IN PARIS.

THE DISTRIBUTION OF COMPRESSED AIR IN PARIS.

In 1879 the first trials were made in Paris of what was afterward known as the Popp compressed air system; the earliest installation was on a very small scale, and for some years the application was limited to the operation of clocks in the streets as well as in private houses. The central station was located in a small building, in the basement of which were two compressors driven each by a 6 H.P. engine; on the first floor were the pressure regulators and other controlling apparatus, and a master clock which distributed pneumatic impulses at minute intervals throughout the system of air pipes.

In a few years, however, applications to obtain compressed air as a motive force became numerous from small users of power, and the rapid increase in demands rendered it necessary to increase the very modest installation in the Rue St. Anne. The first extension was completed in 1880, when the

Rue St. Fargeau works were started on a 60 H.P. basis. Anticipating rapid extension, Mr. Popp, had secured a site of nearly eight acres in the Rue St. Fargeau, and by 1887 no less than 5,000 H.P. were required to compress the air consumed. Fresh extensions followed, and large additional works were completed in 1892 on the Quai de la Gare. At present the development appears to be as follows :

1. Two central stations—those of St. Fargeau and the Quai de la Gare—representing together 13,000 H.P. From these two stations there were distributed through air mains in 1892 no less than 250,000,000 cubic yards of air.
2. Two central time stations for the operation of pneumatic clocks throughout Paris.
3. A *réseau* of 104 miles of mains, of which 41 are devoted to the time service, and 63 miles to the distribution of power for commercial uses ; there is also a total length of the system of service pipes of 61 miles.
4. Sixteen refrigerating chambers in the basement of the Bourse du Commerce.
5. Two stations of about 1,000 H.P., used for generating electricity with compressed-air motors.
6. Twenty-eight hundred H.P. of compressed air consumed for 90 special installations.
7. Seventy-four hundred public and private clocks.
8. Three stations producing compressed air at high pressure, and representing about 1,300 H.P. These are intended for street railroad traction.

The Quai de la Gare works were designed for a total capacity of 24,000 H.P., divided into three groups. The first section of 8,000 H.P. is now at work. The air is compressed by four triple-expansion Corliss engines (2,000 H.P.), and steam is supplied by 20 Babcock & Wilcox boilers, divided into batteries of five. The compressors operate by stages, and have each two low-pressure and one high-pressure cylinder. The air is cooled during compression by spray injectors. The engines are vertical, and the compressors are driven from an overhead shaft.

The following are some particulars of the installation :

Number of sections in each boiler	12
" " tubes per section	9
" " " " boiler	108
Length of tubes	17.8 ft.
Diameter of tubes	3.94 in.
Total heating surface of tubes per boiler	1,958 sq. ft.
Diameter of steam cylinders, high-pressure	33.47 in.
" " " " intermediate	55.12 "
" " " " low pressure	78.74 "
Air-compressing cylinders, "	43.31 "
" " high pressure	30.71 "

The boilers are registered for 170 lbs., and the working pressure is about 140 lbs. per square inch.

The compressors are arranged to deliver into the receivers at a pressure of 114 lbs. per square inch. The quantity of air actually compressed by the four engines per hour to 114 lbs. is equal to about 70,000 cubic meters, or 2,470,000 cub. ft., at atmospheric pressure. The air is compressed by each engine into two reservoirs having a capacity of 1,000 cub. ft., whence it flows into the principal air main, which is 19.69 in. in diameter. The sizes of the mains vary from this diameter to 11.8 in. ; the larger are made of wrought iron welded ; the smaller are of cast iron. The secondary mains range from 7.87 in. in diameter to 1.58 in. ; the service pipes are of lead, and their diameters vary from 3.15 in. to 1.58 in.

When the station on the Quai de la Gare was undertaken the Creusôt Company, who supplied the engines, guaranteed as a maximum consumption of fuel 1.54 lbs. per I.H.P. per hour. The conditions of trials as laid down in the specifications were :

Duration of each trial	6 hours.
Number of revolutions per minute	60
Boiler pressure	163 lbs. per sq. in.
Effective pressure of compressed air	113 lbs.
Maximum indicated H. P.	2,000
Fuel	Briquettes d'Anzin.

An official trial was made only on January 19, 1893, about 13 months after the engines had been in constant work. The following figures give the principal results obtained :

Average number of revolutions per minute	59.635
" pressure of steam in boilers	163 lbs.
" " " " at the admission valve of the high-pressure cylinder	146 "
Average vacuum in the condenser	28.35 in.
Pressure of air in compressors, low pressure	32.7 lbs.
" " " " " high pressure	102 "
Temperature of the air when entering the low-pressure compressors	40.67 F.
Temperature of the air when leaving the high-pressure compressor	69.0 "
H. P. indicated	1996.5
Net fuel consumed per H. P. per hour	1.3 lb.

	Number of Revolutions per Minute.	Total Mechanical Efficiency.	Final Pressure of the Air.	Volume of Air at Atmospheric Pressure Compressed per Hour and per H.P.	Ratio of Actual to Theoretical Work in Compressing the Air.
		Per Ct.	Lbs. per sq. in.	Cubic Ft.	
First trial made by the engineers of the Popp Company..	50	84	74.67	363	1.281
Second trial made by Professor Gutermuth	40	89	85.33	365	1.192

Two trials, at an interval of three months, were made to test the efficiency of the engines and compressors, and the results tabulated above were, it is stated, arrived at.

It would appear, from these trials, that the mean total efficiency is 80.8 per cent. It is claimed that the actual cost of 100 cubic meters (3,530 cub. ft.) of air compressed to 113 lbs. per square inch is .4536 francs, or less than 5*d*. This figure was arrived at after a trial of 24 hours in the station of the Quai de la Gare, and it was confirmed by the results obtained from three months' subsequent working.

INDUSTRIAL APPLICATIONS OF COMPRESSED AIR IN PARIS.

	H. P.								
	Less than 1. H. P.	2 to 6.	7 to 12.	13 to 25.	26 to 50.	50.	100.	150.	
Lithographic printing-presses	34	25	2	1	....	....	....	....	62
Printing	6	4	....	....	2	2	....	....	14
Circular saws, etc.	20	34	3	2	....	....	....	....	59
Cloth-cutting machines	29	2	....	....	....	....	....	....	31
Pumps	....	2	1	....	....	....	....	....	3
Mills	19	2	....	....	....	....	....	....	21
Lathes	58	51	9	....	....	....	....	....	118
Rolling-mills	10	6	....	....	....	....	....	....	16
Refrigerators	3	1	3	....	....	....	....	....	7
Coffee-mills, roasters, etc	13	1	....	....	....	....	....	....	14
Cutting and drilling machinery	7	8	....	....	....	....	....	....	15
Mixing machinery	14	4	....	....	....	....	....	....	18
Sewing machines	53	7	....	....	....	....	....	....	60
Chopping machines, etc	22	7	....	....	....	....	....	....	29
Quilting "	5	1	....	....	....	....	....	....	6
Cutting "	9	1	....	....	....	....	....	....	10
Electrotyping machines	2	1	....	....	....	....	....	....	3
Embroidery "	10	....	....	....	....	....	....	....	10
Shearing, etc. "	5	1	....	....	....	....	....	....	6
Turbines and ventilators	6	11	....	....	....	....	....	....	17
Machines for carding and rolling.	5	5	....	....	....	....	....	....	10
Comb factory	....	....	....	1	....	....	....	....	1
Dynamos	6	6	1	1	2	....	....	....	16
Machines for surgical and dental purposes	4	2	....	....	....	....	....	....	6
Soda-water factory	....	1	....	....	....	....	....	....	1
Provision merchants	3	1	....	....	....	....	....	....	4
Wood-working machinery	2	6	....	....	....	....	....	....	8
Cutting and polishing machinery.	2	....	....	....	....	....	....	....	2
Envelope machinery	3	1	....	....	....	....	....	....	4
Boot machines	1	2	....	....	....	....	....	....	3
Motors	....	....	2	2	....	....	....	....	4
" for ventilating under stations	33	....	....	....	....	....	....	....	33
Motors for dynamos and cold stores	1	10	9	10	1	10	1	1	43
Lifting beer and wine	22	....	....	....	....	....	....	....	22
Elevators, luggage elevators	....	6	4	10	....	....	....	....	20
Blowpipes	96	....	....	....	....	....	....	....	96
Lace and trimming makers	4	....	....	....	....	....	....	....	4
Silk weaving	2	....	....	....	....	....	....	....	2
Total	509	209	34	27	5	12	1	1	798

The applications of compressed air in Paris are very numerous and varied, but according to the latest information the following classification may be made :

1. Distribution of power in quantities ranging from the minute time impulses to motors of 150 H.P. It is worth noticing that in many workshops old steam engines are now worked with compressed air, the boilers serving as reservoirs in which the air is heated before admission to the cylinders.
2. Ventilation and other sanitary purposes.
3. Refrigerators, especially cold stores for the preservation of meat, etc.

At the Bourse du Commerce the installation for this purpose is large, comprising 16 cold-air stores, containing together

5,300 cub. ft. Besides this, compressed air is used to drive motors for electric lighting; the exhaust from these motors is utilized to assist in reducing the temperature of the cold stores. Another series of motors at the Bourse installation is used for heating and ventilating purposes throughout the establishment.

4. The manufacture of ice as a by-product of the compressed air used as a motive power.

5. Elevating or lifting water and other liquids; this is applied chiefly to breweries, but there are large installations at the dépôts of Bercy and the Quai St. Bernard for lifting wines, spirits, etc.

6. Emptying cesspools (*using Retiro*).

7. Passenger and luggage elevators.

8. Pneumatic clocks on the boulevards in Paris and in about 2,000 private houses.

9. Mechanical traction on the Nogent tramways for a distance of about 8¾ miles. This application of compressed air is on the Mekarski system.

The table on page 467 gives an idea of many of the various uses to which compressed air has been put in Paris:

One of the most interesting applications of compressed air in Paris will be that for the propulsion of tram cars on the Conti system, a system already in experimental use, we believe, in Vienna. Some preliminary trials have been made at Nantes and at Nogent, and the results obtained sufficiently good to justify the Compagnie Générale des Omnibus to construct three lines in Paris, which will be opened for traffic during the present year. In the Conti system the air is compressed at a relatively high pressure at a central station; it is then admitted into the mains *B* placed beneath the rails (see diagram, figs. 1 and 2, on previous page).

Branches *C* lead the air nearly to the surface into automatic devices by which the car reservoirs can be charged. By this arrangement it is considered that one central station will be sufficient whatever the length of the line may be; and as the charging devices can be introduced at short intervals, the dead weight of reservoirs to be carried is relatively small. The distance between the charging stations varies according to the circumstances, but for convenience they should be located at the recognized stopping-places. Fig. 3 is a diagram that gives some idea of the arrangement. An iron box is sunk into the roadway to inclose the mechanism; the box is covered by a plate containing two hinged flaps *F* placed immediately over the air nozzle *E*. The nozzle is the continuation of a plunger working in the cylinder *E*, *I*, which can be placed in connection with the air main. As the front truck of the car passes over the rails it strikes the lever *G*, and, depressing it, opens a valve that admits air beneath the plunger *E*, raises it, and causes the air nozzle to push open the flaps *F* and rise above the level of the road. By the time it has reached its full height the nozzle engages in a connection, *H*, communicating with the reservoirs, which are filled in a few seconds. The valve is then closed, and as the car proceeds the lever *G* is released, the air beneath the plungers in the cylinder *E* escapes, and the nozzle falls, the flaps *F* closing over it and restoring the street surface. In the event of the mechanism becoming deranged, air standpipes are provided, so that the reservoirs can be charged by coupling up.

The results obtained will be watched with considerable interest; so, as soon as the system passes out of its experimental stage, which it promises to do shortly under the care of the Compagnie Générale des Omnibus.—*Engineering.*

THE HEATING POWER OF SMOKE.*

It appears to be generally supposed that a large percentage of fuel is lost in smoke, and random statements have been made to the effect that the loss in heating power due to the passing away of combustible matters in smoky furnace gases may reach as high as 30 per cent. of the whole. A little consideration, however, will show that the loss of any large percentage of combustible matter, and consequently of heating power, is quite out of the question. This may be proved in two ways: (1) by calculation of the two sources of heating power as shown by an analysis of coal or dross used for steam raising; and (2) by actual analysis of the furnace gases for combustible solids and gases.

In the following paper are given the results of these two methods of observation, the same dross being analyzed and also employed as fuel in a works furnace, from which smoky gases were given off which were tested for combustible matters.

1. The following is the analysis of the dross employed:

	Per cent.
Gas, tar, etc.	37.63
Fixed carbon	49.97
Sulphur	0.40
Ash	2.72
Water	9.28
	100.00
Heating power (practical) due to gas, tar, etc.	1.16
Heating power (practical) due to fixed carbons.	6.49
	7.65

The points to be observed are the relative proportions of heating power (represented in the analysis by the number of pounds of water 212° F. capable of being evaporated to dryness by 1 lb. of fuel) given out respectively by the combustion of gas, tar, etc., and by the fixed carbon. These are calculated according to Playfair's well-known formula, which was practically tested on coals intended for the British Navy, and which shows that while 1 lb. of fixed carbon is capable when burned of evaporating 13 lbs. of water at 212° F. to dryness, 1 lb. of the gas, tar, etc., will only evaporate 3.1 lbs. From these figures it appears that in the coal or dross, the gas, tar, etc., only contribute 15 per cent. of the total heat given out during the combustion, and that the fixed carbon produces the remainder, or 85 per cent. In coals with less of the former ingredients and more of the latter, which is commonly the case, the proportion given out by the volatile constituents would be considerably reduced. It is thus perfectly clear that even though the whole of the volatile matters (which can alone be accountable for any loss of combustible material) escaped combustion, there could not possibly be a greater loss of heat than 15 per cent. of the whole, even in such an extreme case as this represents.

2. An analysis was made of the furnace gases given off during the burning of the dross of which the results are given above, with the following results:

	Gases very smoky. Per cent. by volume.	Gases almost free from smoke. Per cent. by volume.
Carbonic acid	5.0	3.5
" oxide	none	none
Hydrocarbons	trace	none
Nitrogen	79.9	79.9
Oxygen	15.1	16.6
	100.00	100.00

It has been asserted that carbonic oxide is given off in considerable quantity when much smoke is being produced, but it does not appear in this case; and Hempel, in his work on "Gas Analysis," comes to the conclusion that little or no combustible gases are present in furnace gases. He says: "Furnace gases usually contain only carbon dioxide, oxygen and nitrogen. All other gases are present in but very small amounts. In oft-repeated analyses the author has always found only traces of carbon monoxide, methane and the heavy hydrocarbons." This is in complete accord with the analyses given above, and it may be taken for granted that the presence of carbonic oxide or other combustible gases in furnace gases is a most unusual occurrence. This is quite conclusive evidence that no appreciable loss of heat, even when the furnace gases are smoky, can be attributed to the passing away of the products of imperfect combustion in the gaseous form at least.

That there is loss of combustible matter in the smoke is an undoubted fact, but the quantity seems also to be greatly magnified in certain random statements. In the experiment referred to above the soot was also collected during one hour and a half with the following results:

	Grains per 100 cub. ft. of furnace gases.
Carbonaceous matter	30.81
Ash or mineral matter	20.65
Total soot	51.46

It will be observed that the soot collected consisted largely of mineral or incombustible matter. In several experiments to estimate the soot in furnace gases similar results to those were obtained, and the average would come very close to the quoted results of this special test.

To find how much carbonaceous matter was actually lost as smoke, it will be necessary to know the number of cubic feet of furnace gases given off by the combustion of, say, one ton

* R. R. Tatlock, in the *Chemical News.*

of the dross. If the percentage of carbonic acid in the furnace gases is taken at 5 per cent., the total volume of these given off from one ton of dross would be about 940,000 cub. ft. measured at the ordinary temperature and pressure, and this would contain 41 lbs. of carbonaceous matter and 27 lbs. of mineral matter. This would represent 1.8 per cent. of the volatile matters (gas, tar, etc.), given in the analysis of the dross; and if from this is now calculated the heating power according to Playfair's formula, it will only come to 0.057. This figure, compared with the practical heating power (7.65) of the dross, goes to show that the solid combustible matter of the smoke can only account for the very small percentage of 0.74 of the total heating power which can be obtained from the coal.

From the results of these experiments it is evident that the loss of combustible matters in smoke is very small indeed, and that the belief in immense loss by this cause is simply a fallacy, and it is decidedly not corroborated by experiment. In adopting methods of removing the smoke nuisance, it must therefore be borne in mind that there is little or no gain in burning smoke, and that other methods of dealing with the problem, such as Dulier's smoke absorption process, ought also to receive consideration.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in August, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN AUGUST.

Sioux City, August 2.—Two freight trains on the Chicago, Milwaukee & St. Paul Railroad collided on a bridge at this point. The engineer and fireman jumped and escaped with slight injuries.

Lafayette, Ind., August 3.—Two freight engines on the Wabash Railroad collided near here to-day, and Engineer Clarke was killed.

Field, Man., August 3.—The boiler of a locomotive on the Canadian Pacific Railway exploded near here to-day. The engineer, B. Wheatly, and fireman, A. Hunt, were instantly killed.

Cumberland, Md., August 3.—A coal train was wrecked at Mud Cut, on the Cumberland & Pennsylvania Railroad, to-day, The engine jumped the track and ran against a bank and turned upside down. The engineer was beneath the engine, and with the exception of a few bruises about the face was unhurt; the fireman sustained a slight injury.

Wittenberg, Wis., August 3.—Charles Heulin, engineer on the Milwaukee, Lake Shore & Western Railroad, was killed while at work under his engine early this morning; another freight train backed in against the rear of his freight train, forcing the engine forward and crushing the man under the fire-box.

Urbana, O., August 3.—A passenger train on the New York, Pittsburgh & Ohio Railroad struck a freight car on a siding this morning. Joe Dano, the engineer, was internally injured, and Fireman James Douglas slightly hurt.

Warren, Pa., August 3.—A passenger train on the Dunkirk, Allegheny Valley & Pittsburgh Railroad was ditched here this afternoon. Engineer Beardsly was scalded about the head, and Fireman Robbins was cut on the forehead.

Akron, O., August 3.—A collision occurred between two freight trains on the New York, Pennsylvania & Ohio Railroad to-day. Engineer M. Stack was crushed to death, and his fireman, John Shoop, badly scalded.

Rochelle, Fla., August 4.—A mixed train on the Florida Southern Railroad plunged into a lime sink near here this morning. The engine and two cars were completely wrecked. Engineer Rampaner was seriously injured.

Lima, O., August 4.—A freight train on the Pittsburgh, Fort Wayne & Chicago Railroad ran into an open switch at this point to-day. The engineer and fireman were somewhat bruised.

Cincinnati, O., August 5.—A Panhandle freight was wrecked at Crestonville to-day by running over a cow. The fireman, M. Neil, was killed, and Engineer Egan was slightly injured.

Grand Junction, Col., August 8.—A head-end collision occurred on the Rio Grande Western Railway to-day, in which Fireman Pickering was killed; the engineers of the two engines were seriously scalded.

Des Moines, Ia., August 8.—A cinder dropping from a locomotive on a bridge at Peru caused a smouldering and burning of the main stringers to such an extent that a train on the Chicago Great Western Railroad was wrecked by the collapse of the structure. The engineer and fireman were both killed.

Omaha, Neb., August 9.—A northern-bound passenger train on the Chicago, Rock Island & Pacific Railway plunged over a 50-ft. trestle 4 miles north of Lincoln to-night. Isaac Depew, the engineer, and William Craig, fireman, were killed. Train-wrecking is suspected.

Tacoma, Wash., August 10.—There was a head-end collision on the Northern Pacific Railroad about 15 miles from this city to-day. Engineer L. H. Harmon was instantly killed, and his fireman, E. Martin, was so seriously injured that he died. The accident was the result of an order given by the train despatcher.

Philadelphia, Pa., August 10.—Joseph Haas, an engineer on the Philadelphia & Reading Railroad, fell from his engine to-day and fractured several ribs.

Kansas City, Mo., August 10.—A passenger train on the Southern Kansas branch of the Atchison, Topeka & Santa Fé Railway ran into the rear end of a stock train just east of Olathe to-night. The engineer and fireman were injured by jumping, the fireman's leg being broken and his head and body being badly bruised. Engineer Comstock escaped with a few cuts and bruises and a badly crippled hand.

Mt. Sterling, Ky., August 11.—The engine on the fast train of the Cincinnati Railroad broke a front truck just south of Barren Fork to-day. The engineer and fireman were slightly injured.

Topeka, Kan., August 12.—A collision occurred between two freight trains on the Atchison, Topeka & Santa Fé Railroad, at Hurdland, Mo., to-day, in which Engineer Humphrey was killed. On evidence given by his fireman after the collision, it is probable he died of fright. His evidence was: As they approached the Hurdland switch he moved to Humphrey's side of the cab and said: "Was it not at Gibbs we had orders to stop?" Just then the headlight of the west-bound train showed around the curve. Humphrey said not a word nor moved hand or foot, but looked straight ahead with glassy eyes at the other engine, which was moving at a terrific rate. The fireman spoke to him again, but still the engineer did not move, and the fireman to save his life jumped. The other engineer and fireman reversed their engine and saved themselves by jumping.

Portsmouth, N. H., August 12.—The locomotive on the morning passenger train on the Boston & Maine Railroad jumped the track just outside the depot here to-day. Engineer Dunbar received some injuries about the back and hip, and a fireman by the name of Story was cut about the head and arms.

Charlotte, N. C., August 13.—Charles Briggs, the engineer on the Southern Railway, was struck by a passing train as he stepped off his engine this morning; he was instantly killed.

Buffalo, N. Y., August 13.—A Lehigh Valley freight train ran into a Buffalo Creek freight engine near the city limits to-day. Both were backing at the same time, and the morning was densely foggy. George Pitts, one of the engineers, was slightly hurt about the back.

Albuquerque, N. M., August 16.—A passenger train on the Atlantic & Pacific Railroad was wrecked by a washout at Cubero this morning. The engine was ditched, and James H. Orton, fireman, was killed, and William Norris, engineer, was dangerously injured.

South Whitley, Ind., August 16.—A freight train on the Cumberland, Wabash & Michigan Railroad was run into at a crossing here by a Wabash freight train. The engineer and fireman of the latter train jumped and were slightly injured.

Owensburg, Ky., August 17.—A freight train on the Hardensburgh branch of the Louisville, St. Louis & Texas Railroad was wrecked to-day. Fireman Wick Dehannen was fatally injured.

Sioux City, Ia., August 17.—A fast freight on the Sioux City & Pacific Railroad ran into a box car at River Sioux to-day. The engine and six cars went down an embankment, and Engineer Moorey and Fireman McKenney were badly injured.

LOCOMOTIVE RETURNS FOR THE MONTH OF JUNE, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Locomotive Mileage. Freight Trains.	Locomotive Mileage. Service and Switching.	Locomotive Mileage. Total.	Locomotive Mileage. Average per Engine.	Av. Train. Passenger Cars.	Av. Train. Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Coal Burned per Mile. Freight Train Mile.	Coal Burned per Mile. Service and Switching Mile.	Coal Burned per Mile. Train Mile, all Service.	Coal Burned per Mile. Passenger Car Mile.	Coal Burned per Mile. Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Cost per Locomotive Mile. Fuel.	Cost per Locomotive Mile. Oil, Tallow and Waste.	Cost per Locomotive Mile. Other Accounts.	Cost per Locomotive Mile. Engineers and Firemen.	Cost per Locomotive Mile. Wiping, etc.	Cost per Locomotive Mile. Total.	Cost per Car Mile. Passenger.	Cost per Car Mile. Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	863	782	....	....	1,496,125	1,755,171	2,911	....	....	....	....	....	86.06	....	...	4.33	8.92	0.21	1.46	6.88	0.19	21.94	....	...	1.90
Canadian Pacific	604	....	467,625	726,084	194,936	1,389,645	2 300	....	....	....	....	...	61.25	....	....	2.30	9.35	0.30	....	5.62	1.26	18.83	....	....	3.08
Chic., Burlington & Quincy	541	...	....	....	....	1,284,127	2,373	4.93	20.23	....	....	....	78.11	....	.	4.34	7.96	0.17	0.17	6.87	0.04	19.55	....	....	2.04
Chic., Milwaukee & St. Paul	855	....	....	....	....	2,235,682	2,626	....	...	....	....	....	52.68	....	....	3.89	7.97	0.26	...	6.93	...	19.05	....	....	3.00
Chic., Rock Island & Pacific	564	....	479,996	779,387	297,830	1,557,213	2,565	5.50	18.20	49.04	62.40	36.04	49.16	9.16	3.82	2.77	5.32	0.23	2.77	6.14	0.42	17.65	....	....	2.40
Chicago & Northwestern	....	....	805,993	1,236,043	597,007	2,639,043	....	....	....	....	....	....	73.21	....	....	3.56	8.60	0.28	....	6.31	0.88	19.63	....	....	....
Cincinnati Southern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	...	....	....	....	...	....	....
Cumberland & Penn.*	23	22	8,615	14,898	....	23,513	1,022	....	....	....	....	....	63.45	....	...	3.59	3.17	0.33	....	...	2.66	9.75	...	....	....
Delaware, Lackawanna & W. Main L.	213	200	71,675	694,607	5,450	771,732	3.858	....	....	....	....	....	90.77	....	....	2.68	6.88	0.40	....	5.68	....	15.64	....	....	1.50
Morris & Essex Division	163	....	180,090	145,351	101,615	427,056	2,619	....	....	....	....	....	60.53	....	....	3.81	9.50	0.38	....	6.38	....	20.07	....	....	3.10
Flint & Père Marquette	....	....	87,170	55,088	53,588	195,846	2,577	....	....	....	....	....	26.05	....	....	3.07	5.33	0.15	...	5.23	0.90	14.68	....	....	1.85
Hannibal & St. Joseph	68	....	68,784	112,617	31,823	213,224	3,231	4.88	16.68	....	....	....	67.47	13.25	5.04	2.45	5.91	0.09	0.24	6.73	0.03	15.45	....	....	1.85
Kansas City, Ft. S. & Memphis	150	....	91,621	193,909	83,502	369,032	2,929	....	....	....	....	....	65.75	....	....	2.92	3.56	0.20	0.39	7.22	...	14.29	....	....	1.14
Kan. City, Mem. & Birm	42	36	26,752	46,463	10,759	83,974	2,333	....	....	...	....	....	69.48	....	....	3.14	3.14	0.28	0.30	7.35	....	14.21	....	...	0.87
Kan. City, St. Jo. & Council Bluffs	...	....	51,051	39,044	39,800	129,895	3,608	5.01	23.07	....	....	....	63.28	12.83	3.89	3.23	6.16	0.13	0.10	6.32	0.04	15.98	...	...	2.04
Lake Shore & Mich. Southern	592	....	369,189	612,865	339,252	1,321,306	2,231	....	....	54.23	83.02	21.49	62.18	....	....	3.36	7.80	0.12	0.17	6.88	0.05	18.38	....	....	2.50
Louisville & Nashville	....	....	....	....	....	....	...	....	....	....	...	....	....	....	....	..	....	....	....	....	....	....	...	....	....
Manhattan Elevated	....	295	740,477	....	65,202	805,679	2,731	....	....	....	....	....	37.73	....	....	2.40	7.60	0.20	....	9.10	....	19.30	....	....	4.03
Mexican Central	148	135	....	....	....	415,285	....	....	....	....	....	....	65.50	....	....	5.25	11.80	0.48	....	4.91	0.10	22.54	...	....	3.55
Minn., St. Paul & Sault Ste. Marie	107	77	79,267	78,033	31,893	189,193	....	5.02	19.86	....	....	....	53.54	....	....	2.36	7.90	0.24	....	6.76	....	17.26	3.02	1.07	....
Missouri Pacific	....	351	....	....	848,129	....	2,914	4.26	17.12	....	....	....	80.48	....	....	5.43	6.11	0.32	1.38	6.42	1.54	21.18	4.15	1.54	1.48
Mobile & Ohio	107	82	54,891	146,095	50,465	251,451	3,143	....	....	....	....	...	63.80	....	....	2.17	4.61	0.21	0.70	5.59	1.08	14.36	....	....	1.43
N. O. and Northeastern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	...
N. Y., Lake Erie & Western	....	625	431,671	755,607	225,352	1,412,630	2,580	4.50	25.10	90.70	140.70	81.90	104.40	20.20	5.60	4.24	8.54	0.35	1.84	7.43	1.21	23.61	....	....	1.60
N. Y., N. H. & H., Old Colony Div	....	....	409,172	166,732	192,119	....	....	4.00	17.00	....	....	....	60.18	15.50	5.00	3.53	9.04	0.55	....	6.97	0.71	20.80	....	....	...
N. Y., Pennsylvania & Ohio	281	....	128,307	328,528	123,710	580,545	2,065	5.30	19.90	63.40	119.50	120.40	134.40	11.90	6.10	4.14	10.40	0.30	1.98	7.39	1.18	25.39	....	...	....
Norfolk & Western, Gen. East. Div.†	....	....	93,627	331,374	51,678	476,679	2,979	5.18	20.90	47.66	114.69	....	67.76	9.20	5.48	4.98	3.36	0.26	....	....	....	8.60	....	....	3.20
General Western Division†	....	....	103,293	412,409	60,420	576,122	3,031	5.01	16.49	73.00	127.00	....	119.00	14.56	7.72	10.93	3.69	0.23	....	....	....	14.85	....	....	....
Ohio and Mississippi	....	...	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	....	...	....	....	....	....	....
Philadelphia & Reading	....	...	430,438	792,886	445,093	1,668,417	3,391	....	....	....	....	....	76.70	...	...	4.80	4.62	0.36	....	5.77	0.42	15.97	....	....	...
Southern Pacific, Pacific System	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Union Pacific	867	....	478,480	866,053	332,384	1,676,917	3,299	6.15	18.47	....	....	....	91.53	15.60	6.90	8.74	9.43	0.38	....	8.11	1.15	27.81	4.36	1.99	2.05
Wabash	...	...	....	....	....	....	...	....	....	....	....	....	....	....	...	....	....	....	....	....	....	....	....	....	....
Wisconsin Central	149	108	142,065	150,469	73,746	366,280	....	....	....	....	....	....	62.30	....	....	2.67	9.11	0.15	....	7.04	....	18.97	...	....	2.91

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

Lexington, Ky., August 18.—A fast Florida train on the Cincinnati & Southern Railroad was wrecked by a misplaced switch at Brannon. The engineer and fireman were seriously injured.

Worcester, Mass., August 18.—There was a head-end collision between an Adams Express train and an accommodation train at this point to-night. The engineer of the Adams Express train did not see the red light placed on the west-bound track to protect the accommodation train while the latter ran over the cross-over. He was slightly injured.

St. Louis, Mo., August 19.—A freight train on the Wabash Road struck a horse 2 miles west of Jonesborough, killing Engineer C. Welton, and Fireman Ray Tilton was so badly injured that he subsequently died.

St. Louis, Mo., August 20.—A fast express on the Vandalia Line was ditched near Pocahontas this evening. Engineer Manafee and Fireman Dickinson were seriously injured. The cause of the wreck is unknown.

Haynes Falls, N. Y., August 20.—A collision occurred between a wild engine and that of a passenger train on the Ulster & Delaware Railroad, at Stony Clove, to-night. The engineer and fireman jumped and were slightly injured.

San Antonio, Tex., August 20.—A fast train was wrecked on the Southern Pacific Railroad near Eldridge. Charles E. Ford, the fireman, was killed.

Dunkirk, N. Y., August 20.—An engine on the Dunkirk, Allegheny Valley & Pittsburgh Railroad was wrecked by a misplaced switch to-day. The engineer jumped and was quite badly bruised.

Ellenburg, Wash., August 20.—A freight train was wrecked on the Seattle, Lake Shore & Eastern Railway, near Latona, this evening, by striking a cow. The engine was thrown into a ditch, and the tender ran into the back end of it, killing Fireman J. Black; the engineer was somewhat injured.

Colorado Springs, Col., August 21.— A freight train on the Colorado Midland Railroad was wrecked by a landslide 10 miles from Idlewild. Engineer John B. Blocker was instantly killed.

Huntington, Pa., August 24.—There was a collision between two heavily loaded freight trains on the Pennsylvania Road near here this morning. Engineer Preston had both legs severed from the body, and they were subsequently found in a burning fire-box. He died from the result of his injuries.

Parkersburg, W. Va., August 27.—A passenger train on the Baltimore & Ohio Railroad ran into a boulder near Cairo this morning, throwing the engine from the track. Fireman Shaughnessy was killed, and Engineer Flannery was fatally injured.

Chicago, Ill., August 27.—A passenger train on the Chicago & Eastern Illinois collided with a switch train at Thirty-seventh Street to-day, fatally injuring the fireman.

Ottumwa, Ia., August 30.—There was a collision between two freight trains on the Chicago, Burlington & Quincy Railroad, near Cleveland. Gus Starkman, the engineer, was instantly killed, and Ed. Walker, a fireman, fatally injured.

Springfield, Ill., August 30.—A freight train ran into an open switch near Dawson this evening. Engineer Atkinson and his fireman were badly injured, the engineer probably fatally.

Grand Rapids, Mich., August 31.—A fast passenger train on the Chicago & West Michigan Railroad ran into a couple of cows south of Baldwin to-day. The engine was overturned, and Engineer John S. Patterson so badly injured that he died shortly afterward. John Kobe, of Grand Rapids, was instantly killed by being crushed under the engine.

Our report for August, it will be seen, includes 41 accidents, in which 17 engineers and 15 firemen were killed, and 22 engineers and 15 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosion	1
Broken truck	1
Cattle on track	4
Cave-in	1
Collisions	14
Crushed under engine	1
Derailments	3
Falling from engine	1
Landslide	2
Misplaced switch	4
Struck by passing train	1
Struck car on siding	2
Train-wreckers	1
Trestle burned	1
Unknown	3
Washout	1
	41

PROCEEDINGS OF SOCIETIES.

Master Car Builders' Association.—The Secretary has just issued a circular giving the subjects and committees for the convention that is to be held in June, 1895. The subjects and the chairmen of the committees are as follows:

1. Interchange of Cars.—To suggest how cars in interchange may be maintained equitably to owners and operators with the least expense and detention. Chairman, Pulaski Leeds, S.M.P., Louisville & Nashville Railroad, Louisville, Ky.

2. Road Tests of Brake Shoes.—To conduct and report upon a series of comparative tests of different brake shoes in service, with as complete data as possible. Chairman, R. H. Soule, S.M.P., Norfolk & Western Railroad, Roanoke, Va.

3. Laboratory Tests of Metal for Brake Shoes.—To conduct and report upon laboratory tests of different brake shoes, with as complete data as possible. Chairman, S. P. Bush, S.M.P., Pennsylvania Company, Southwest System, Columbus, O.

4. Lubrication of Cars.—Continued from 1894 to pursue its own recommendations as to tests of oil for lubrication, and to consider the economics of journal bearings as suggested in this report if feasible. Chairman, A. M. Waitt, M.C.B., Lake Shore & Michigan Southern Railway, Cleveland, O.

5. Air-brake Tests.—Chairman, G. W. Rhodes, S.M.P., Chicago, Burlington & Quincy Railroad, Aurora, Ill.

6. Air-brake and Hand-brake Apparatus on Cars.—Continued from 1894 to consider the questions raised in its report, and to include the standard levers and all other questions of importance pertaining to the subject. Chairman, E. D. Bronner, M.C.B., Michigan Central Railroad, Detroit, Mich.

7. Automatic Couplers.—To advise what changes may be desirable in the standard size of M. C. B. automatic coupler shanks, and to recommend a standard yoke or pocket strap for rear-end attachments to cars. Chairman, J. M. Wallis, Mech. Supt., Grand Trunk Railway, Montreal, Can.

8. Mounting New and Second-hand Wheels.—To report upon the best method of mounting new and second-hand wheels so that they may be properly located upon the axle. Chairman, J. N. Barr, S.M.P., Chicago, Milwaukee & St. Paul Railroad, Milwaukee, Wis.

9. Passenger Car Ends and Platforms.—To consider what improvements may be made in the construction of passenger ends and platforms for increased strength in ordinary service and emergencies. Chairman, E. W. Grieves, M.C.B., Baltimore & Ohio Railroad, Baltimore, Md.

10. Coal Car Sides.—To suggest best methods of construction and staying of the sides of 60,000-lbs. capacity coal cars with high sides. Chairman, R. E. Marshall, S.M.P., Philadelphia, Wilmington & Baltimore Railroad, Philadelphia, Pa.

He has also issued a notice calling the attention of the members to the wheel gauges. This circular states that in seeking to make arrangements with gauge manufacturers to furnish the gauges recently adopted, the Executive Committee finds that in order to make the most satisfactory arrangements as to prices it is desirable to have some idea as to how many sets of gauges will be ordered soon. If as large a number as 50 sets of each kind can be guaranteed, the manufacturers' prices will be much lower. The gauges comprise: 1. Maximum and minimum wheel flange thickness gauge. 2. Check gauge for mounting wheels. 3. A set of nine journal-bearing and wedge gauges. If 50 sets of each kind can be guaranteed to manufacturers, the prices will not exceed the following figures: For No. 1, $6.30; No. 2, $31.50; No. 3, $40.50.

American International Association of Railway Superintendents of Bridges and Buildings.—The committee appointed by this Association to report on the subject of Depressed Cinder-pits and Other Kinds have issued a circular of inquiry asking for information on this subject. The questions asked are: What system for dumping and removing ashes from locomotives is in use on your road? Give general description and the location, whether in a main track, side track, or special track. If a pit is used, give depth, clear width and length, and describe in general the kind of foundation, materials in side wall and bottom of pit, coping, rail fastenings or supports, drainage, and the methods used to protect against heat. If a conveyor system, elevated platform with dumping trestle, or other method in use, describe same, giving principal dimensions, materials and details. What is the arrangement, location and height of ash-car track in relation to the pit or dumping track? What kind of coal is used? Does the choice or dimensions of a cinder-pit system depend to a certain extent on the kind of coal used, and, if so, in what respect? It is particularly desired to obtain first cost of cinder-pits or other systems for removing ashes; also the unit cost of operation—*i.e.*, handling the ashes from pits to cars—and the

output capacity of a pit or plant of given size. We are especially desirous of obtaining blue prints of cinder-pit systems in actual use on your railroad, with such remarks as you may feel willing to make on the efficiency of the design, the reasons for its adoption, and any possible improvements you might have to suggest or general views to offer on the subject of the best system to recommend under stated conditions. The committee is composed of the following members: Walter G. Berg, Lehigh Valley Railroad, Jersey City, N. J.; Abel S. Markley, Pittsburgh & Western Railroad, Alleghany, Pa.; George W. Andrews, Baltimore & Ohio Railroad, Philadelphia, Pa.; R. M. Peck, Missouri Pacific Railroad, Pacific, Mo.

New York Railroad Club.—The first meeting of the season was held at the rooms of the American Society of Mechanical Engineers on Thursday evening, September 20. Mr. W. W. Wheatley, Car Accountant for the West Shore Railroad, read a paper on the Best Way of Improving the Present Methods of Rating Train Loads. He called attention to the fact that the present method of rating was very deficient in that it was on the basis of loaded car, and the load in a nominally rated car might be anything from a load of butter, as was instanced in one case, to a full complement of 30 tons. It was evident, therefore, that unless some method was devised for giving dispatchers and yardmen the necessary information to enable them to load a locomotive with a proper load in tons, the weight of the train might continue to vary between very wide limits. In the discussion that followed the stand was taken that this rating by weight should be put in execution in all instances of west-bound as well as east-bound freight to be so rated, as cars must be hauled westward at any rate, and it mattered little whether freight was distributed through a dozen cars giving each a load of 2 tons, or whether it were all loaded in one car. In reply to this it was maintained that if the west-bound trains were loaded by weight, longer trains could be hauled than the east-bound engines could handle, so that fewer train crews would be needed going west, and those that had been carried over the road eastward could be sent back, deadhead, on passenger trains at a less expense than if they were in charge of freight.

OBITUARY.

James Nelson Lander.*

The death of J. N. Lander, the well-known Superintendent of Motive Power of the lines of the New York, New Haven & Hartford Railroad east of Hartford, Conn., occurred at his home in Concord, N. H., on Tuesday, August 28. His appearance at the June conventions held in Saratoga then filled all his friends with apprehension, as it was evident that disease had taken a strong hold on his generally robust constitution.

He was born in Topsham, Vt., on May 29, 1838, and was the son of George and Jean (Laird) Lander, and was educated in the public schools of his State.

At the age of 15 years he entered the machine shop of A. Latham, at West Lebanon, as an apprentice, and he there started on his subsequent career in the mechanical world. He remained at West Lebanon for about 10 years, and then went to Concord, N. H., in the employ of the Northern Railroad as Foreman in the machine shops of that company.

In 1865 he succeeded Mr. James Sedgely as Master Mechanic of the Northern Railroad, and held the position until 1881, when the Concord and Boston & Lowell railroads, having consolidated under a business arrangement, he was appointed Master Mechanic of the two roads. This agreement was subsequently annulled by the courts, and he was then offered and accepted the position of Superintendent of Motive Power of the Mexican Central Railroad, then in process of construction. He remained in Mexico only about a year, however, and then returned to New England and received the appointment of Superintendent of Rolling Stock of the Old Colony Railroad, and upon the consolidation of that system with the New York, New Haven & Hartford Railroad, he was continued as Superintendent of Motive Power of all the lines embraced by the new system east of Hartford. This position he held at the time of his death.

The fact that for many years he was connected with the Fire Department of Concord will furnish a key to his character, or, rather, his disposition, which was shown by a strong liking for companionship. Wherever he was found, if there were any acquaintances within reach, he was the center of a circle which was always entertained by his vivacity and the expressions of his strong convictions, which he seldom hesitated to utter.

In 1870 he became a member of the American Railway Master Mechanics' Association, and was ever afterward active and interested in its proceedings. Nearly every year he served on one or more committees of investigation, and always devoted much time and thought to the work which he was appointed to do. He was made a Vice-President in 1877, and held that office until 1881, when he was elected President, and served in that capacity for two years. He was also for a number of years a representative member of the Master Car Builders' Association, but his name does not appear in the recent lists of members of that association, probably for the reason that when the Old Colony Line was consolidated with the New York, New Haven & Hartford Line, the car department of the former was placed under the jurisdiction of another head.

At the time of his death he was chairman of a committee appointed to confer with the American Railway Association, with reference to securing the required money for making shop tests of locomotives at Purdue University. His services in that connection will be sadly missed. The duties entrusted to that and to another committee, which it is expected will conduct a series of such tests, are of a very responsible character, and unless the work which is proposed is very wisely managed, serious dissatisfaction may result.

Of Mr. Lander's professional career it may be said that the general attitude of his mind leaned toward conservatism. He was not much attracted by brilliant invention or startling novelties. Like many other people, he always had a great deal more confidence in things which had been done than in those which only held out the promise of important results. When the success of any new enterprise was assured, he was always ready to take it up. He was greatly interested in compound locomotives; and it was through his patronage that Mr. F. W. Dean was able to develop his designs into actual practice. Mr. Lander was apparently a strong believer in the compound system, but at the same time was disposed to move slowly in its adoption.

He always held very decided views on all subjects, especially in politics, and was a stanch Republican, and represented one of the wards of Concord in the Legislature of New Hampshire for two terms. Ever since he lived in Boston he was a resident at the United States Hotel, where he could usually be found during the evening occupying what was jocularly called the "Ananias Corner," where he received and entertained any of his friends who were within reach. He took an active part in the Proceedings of the New England Railway Club, of which he was a member. He will hereafter be sadly missed by the members of all the organizations to which he belonged.

He leaves a wife and one son, George N. Lander, who is an electrical inspector in the employ of the New Hampshire Board of Fire Underwriters. The burial was in Blossom Hill Cemetery, near Concord, and the funeral was attended by many prominent railroad officers and other old friends.

John Newell.

The news of the death of John Newell, President and General Manager of the Lake Shore & Michigan Southern Railway, who died at Youngstown, O., on August 27, reached us too late to be announced in our last issue. Of his life and death it was said in the *Travellers' Official Guide:*

"His death was the result of a slight stroke of paralysis, undoubtedly caused by overwork. Mr. Newell was 62 years old at the time of his death. He occupied a position of influence far greater than was necessarily connected with the important offices which he held. His will was most indomitable, and his capacity for business was enormous. He entered the railway service in 1846 as a rodman, and was afterward Assistant Engineer of the Central Vermont Railroad. In 1851 he worked on the extension of the Champlain & St. Lawrence Railroad, and in 1852 and 1853 he surveyed the routes of railroads from Louisville to Cincinnati and from Saratoga to Sackett's Harbor, N. Y. In 1855 he was Engineer of the old Cairo City Railroad, and from 1856–65 Engineer of Maintenance of Way of the Illinois Central Railroad. From 1865–68 he was President of the Cleveland & Toledo Railroad, now a part of the Lake Shore, and during the next succeeding year Engineer and Superintendent of the New York Central. From 1869–71 he was Vice-President of the Illinois Central and for 3 years after that President of the same road. In 1875 he became General Manager of the Lake Shore, and since 1883 he

* For many of the following facts relating to his life, we are indebted to a Concord paper.

has been both President and General Manager of the same road. At the time of his death he was also President of the Pittsburgh & Lake Erie Railroad."

Mr. D. W. Caldwell has been elected General Manager of the Lake Shore Road to succeed Mr. Newell. It is understood that Mr. Caldwell will eventually succeed to the presidency.

PERSONALS.

Mr. W. H. Thomas is hereby appointed Assistant Superintendent of Motive Power, with jurisdiction over both the Eastern and Western systems. All officers and employés in the motive power department will obey his instructions.

R. D. Wade, Superintendent of Motive Power of the Southern Railway Company, has had his jurisdiction extended to include the Eastern system. The assistant superintendents of motive power and master mechanics will report and receive their orders from him; road firemen of engines, as well as engineers and firemen, are under his control, and report to him through the master mechanics in all matters relative to the condition of locomotives; but in matters pertaining to the discipline on the road they are under the direction and control of the superintendents, who have full authority to suspend or discharge them.

Manufactures.

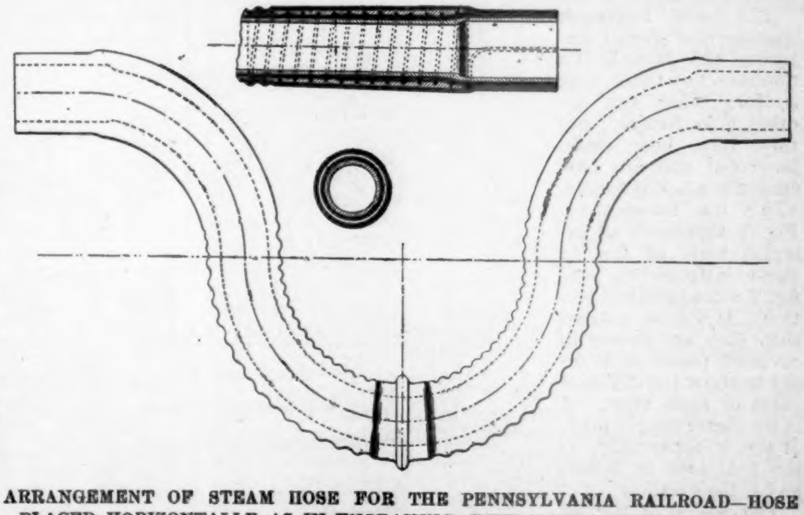
STEAM HOSE.

One of the practical difficulties encountered in heating cars with steam, and also in operating air brakes, is in getting hose for conducting the steam and compressed air from one car to the other, which will stand the service in which it is used. By the action of the steam especially a process of decomposition, or, rather, disintegration, takes place of the inner lining of the hose, which becomes softened and swells, and in time becomes exfoliated and is detached in shreds from the body of the hose, and the inner coating is thus ultimately destroyed. The hose, in fact, is subject to a process of deterioration, the effects of which are analogous to those resulting from inflammation of the bowels of men and other animals. The heat of the steam inflames or swells the inner lining of the hose, which diminishes its internal diameter; and later, as stated, shreds are detached which are carried into the pipes and to the valves and other attachments of the heating apparatus, thus clogging them and interfering with their action.

For a long time the belief was entertained by manufacturers of rubber hose that, in order to withstand the action of steam, it was necessary to compound the material of which it is made with large quantities of mineral substances. After much fruitless experiments it was discovered that this was a mistake. Experience in this direction was, in fact, somewhat like early experience with lubricants. Some of us can remember the time, before petroleum was discovered, when the mechanical world still enjoyed the benefits of that unrivaled lubricator, sperm oil. As the use of machinery was extended and increased the demand for the oil exceeded the supply, and it became too expensive for general use, and a substitute was sought in various directions. In this connection the writer recalls an early incident of his old boss, Ross Winans, who had the commendable characteristic that he would always give whoever came to see him a hearing if he deserved it. One day a dapper salesman came to the office to sell some new "blended" oils, and dilated at considerable length on the skill with which a variety of ingredients were compounded so as to produce the best results. Winans listened to him with great patience until he was through. "Well," he said, "what you say may all be so; but I have been using oil for more than forty years, and my experience is that there is nothing as good as pure sperm oil, and the more you mix the d—n stuff the worse it gets." The experience of some of the manufacturers of hose regarding india-rubber corresponds with that of Winans with reference to oil. The purer and the better the rubber, the less mixing is required to get good service out of it.

After the difficulties which have been described in the use of hose were encountered, it was attempted to retain its inside diameter and to obviate the effects of the swelling of its lining by inserting a coil of wire. This, however, resulted in little or no benefit, but was rather an injury, as the rubber would swell between the wire and would thus protrude inwardly, and the wire, by being heated and through mechanical action, chafed the rubber and detached it in shreds, so that the hose was ultimately destroyed much quicker than it was when wire was not used.

To carry our pathological simile a little further, it may be said of rubber hose, as of mankind, that a prime condition essential to longevity and health is to be properly born, and to have a good constitution to begin with. It is of the utmost importance that the original materials of which hose is constituted should be the best obtainable. The Peerless Rubber Manufacturing Company and others have spent much time and money in the investigation of the conditions essential to the longevity of rubber hose, and their conclusion is that, like animals, good stock is one and a very important safeguard against what may be called the intestinal diseases to which hose is liable, and that the best stock which can be used is fine Para rubber. With a good original constitution, the pathological parallel may be carried still further. It is found that for diseases of organisms thus constituted very simple remedies are required. Some years ago, while Mr. C. H. Dale, the General Manager of the Peerless Rubber Manufacturing Company, was in England, he discovered a very simple compound of which steam hose manufactured there is made, the basis, however, being fine Para rubber. While it is thought by good Americans, who are believers in the McKinley tariff, that foreign manufacturers are not the peers of the Peerless Rubber Company, it is true, nevertheless, that steam hose made of the compound discovered by Mr. Dale has given phenomenal results. While no pretense is made that there are any great secrets in the compounding of rubber for mechanical purposes, nevertheless the ingredient referred to is not generally known. It may be added, however, that it is a very simple remedy for the disorders of rubber hose, and it in no way interferes with the elasticity and flexibility of the gum with which it is compounded. In this respect it differs from all of the minerals heretofore employed in compounding. In order to get the best service it is necessary that the tube, friction, coating and jacket of the hose should all be made of the same fine material throughout. This necessarily increases the price of hose quite largely, and in these hard times it is not easy to convince buyers that the more expensive article is the cheapest in the end. It is asserted by the Peerless Rubber Manufacturing Company that all of the steam hose manufactured by them for car heating during the years 1893 and 1894, on this principle, gave very satisfactory results, wearing the entire season; and it is safe to say that 80 per cent. of it is still in good condition and fit for service for the season of 1894-95. They are prepared to supply hose for car heating with a guarantee of one season; and they claim that there is no question but that 90 per cent. of it will wear two seasons in service provided it is properly cared for and removed during the summer months, when steam



ARRANGEMENT OF STEAM HOSE FOR THE PENNSYLVANIA RAILROAD—HOSE PLACED HORIZONTALLY AS IN ENGRAVING, THUS DOING AWAY WITH SAG.

heat is not needed—that is, if it is taken off the cars and carefully stored until required in the fall.

The office of the Peerless Rubber Manufacturing Company is at No. 16 Warren Street, New York.

THE HANCOCK LOCOMOTIVE INSPIRATOR FOR 1894.

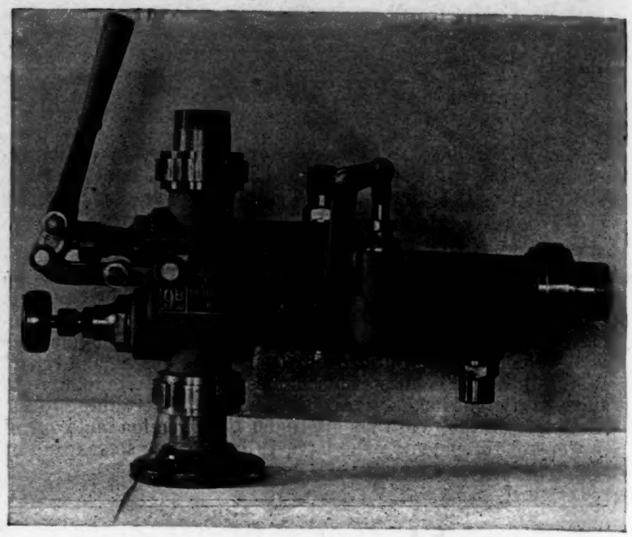
One of the most important elements in a good injector for locomotive service is its ability to operate efficiently through a wide range of steam pressures without adjustment. Many devices have been invented and placed upon the market to accomplish this end, but in nearly every case it has only been partially and very imperfectly effected by automatic devices of various kinds.

It has been found impossible to make a reliable jet apparatus that will work successfully through a range of 200 lbs. of steam pressure where one jet only is employed without using automatic devices for movement of its parts. The double-jet apparatus for use on locomotives as heretofore constructed, and to be operated with one movement, has been too complicated for practical use, the movement of its parts being confined to strictly time adjustment in their relations one to the other. This was a very objectionable feature in the old style of locomotive inspirator which has been wholly overcome in the improved locomotive inspirator of 1894. Such has been the press of business in other kindred lines that the Hancock Company have not been able until quite recently to devote the time and attention necessary to the development of a new and practically perfect locomotive inspirator.

The 1894 instrument made by the Hancock Inspirator Company differs from the locomotive inspirators hitherto made by that company, in that it is very much simplified in its construction and operation; it is also much more efficient, and is especially constructed for the extreme service required by the locomotive. It operates with from 30 to 250 lbs. steam pressure without adjustment, and has a minimum capacity of 50 per cent. of its maximum. It will take water at a temperature of 120° F. at any steam pressure, and cannot be balked by a hot machine or suction caused by a leaky steam valve, or by blowing back into the tank, and it will deliver a constantly increasing supply of water with increasing steam pressures.

The new inspirator contains the special feature of the old style of a double set of tubes, one, *a*, for lifting and the other, *b*, for forcing; but these have been much improved and are now specially adapted for service on locomotives. Fig. 1 represents an external view of one of these instruments, and fig. 2 a longitudinal section. It will be noticed that they are shown in reversed positions, in order to show the different parts in each view. *A* is the steam supply pipe, *B* the water supply, *D* the feed pipe to boiler, and *C* the overflow.

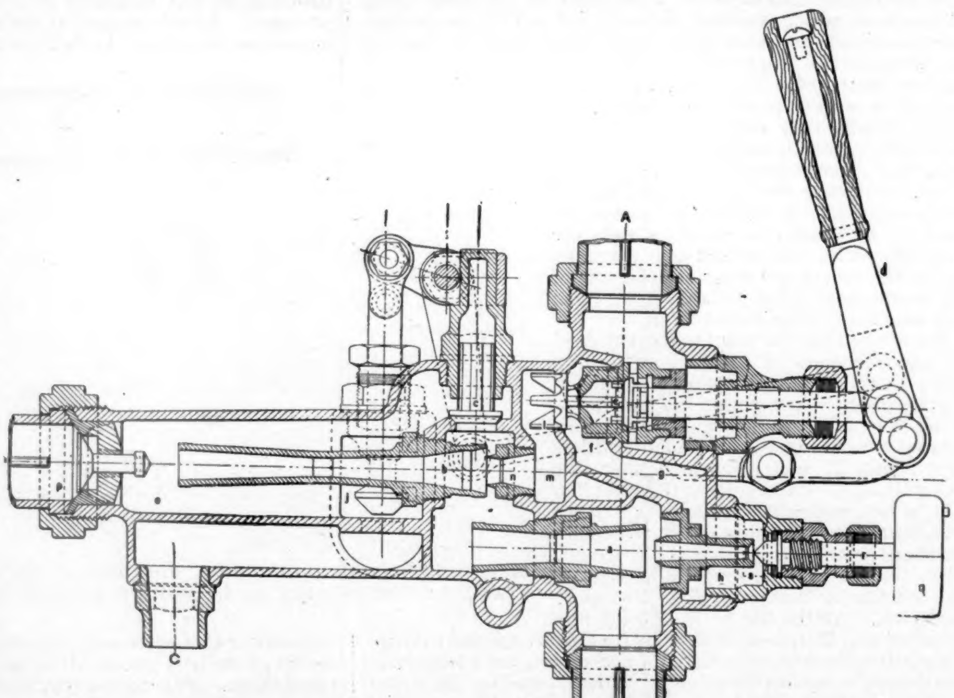
The action of the inspirator is controlled by a double steam valve peculiar to this form of inspirator, consisting of a valve, *e*, within another valve, *f*. The inner one, *e*, is opened by a slight movement of the lever *d*, which admits steam to the chamber *g* and to the lifter nozzle *h*, which starts the water flowing through the combining tube *a* into the chamber *i*. The water pressure in this chamber raises the intermediate valve *c* and allows the water to flow upward and then downward, and it escapes through the overflow valve *j* into the chamber *k* and out through the overflow pipe *C*. When a current of this kind is once established the lever *d* is drawn farther toward the right, which opens the main valve *f* and allows steam to flow through the opening at *l* into the chamber *m* and through the nozzle *n* into the tube *b*. This starts the forcing current of water through the tube *b* into the chamber *o*. The pressure in



THE HANCOCK LOCOMOTIVE INSPIRATOR.

o then closes the valve *c*, and a further movement of the lever *d* closes the overflow valve *j*. As soon as the pressure in *o* exceeds the boiler pressures, the check valve *p* is opened and the current of water flows through the feed pipe *D* into the boiler.

In order to regulate the amount of water fed to boiler a device is provided which consists of a valve, *s*, on the end of a spindle, *r*, which is operated by a handwheel, *q*. By this means the feed may be regulated from the maximum to the minimum capacity without touching the lever and without using a lazy-cock or regulating valve in the suction. This is claimed to be the first adaptation of this device for this purpose ever successfully applied to a jet apparatus.



LONGITUDINAL SECTION OF THE HANCOCK LOCOMOTIVE INSPIRATOR.

The operation of the machines when put to work is as follows: A slight pull of the lever *d* opens the valve *e*, which admits steam through the main valve *f* and steam ports to the lifting side *g* and lifter steam nozzle *h*. The flow of steam

through the lifter tube *a* then produces a partial vacuum in the chamber *t* and suction pipe *B* which causes the water to flow upward through *B* and through the lifter tube *a* into the forcing chamber *i* and through the intermediate overflow valve *c*, which opens to the chamber containing the valve *j* and to the chamber *k* and overflow pipe *C*. The intermediate overflow valve *c* being located above the mouth of the forcing tube *b*, allows a quantity of water to flow through it and around the forcing nozzle *n*, which is sufficient to condense the steam which flows through it, and which at this period is admitted to it by a further movement of the lever *d* and valve *f*. This current of steam starts the jet of water through the tube *b* which raises the pressure in the delivery chamber *o* above that in the forcing chamber *i*, which causes the intermediate valve *c* to close, thus diverting all the water through the tube *b* and thence to the boiler, where the final overflow valve *j* is closed by the complete movement of the lever *d*. This operation, which takes many words to describe, is effected in practice in a few seconds.

These inspirators are made in four styles, to fit the connections of all standard injectors in common use. The Hancock Inspirator Company have the best possible facilities for producing these goods; they have a large factory and brass foundry filled with the latest improved machinery and employ the best engineering and mechanical talent to be obtained, thus insuring the highest possible efficiency and the greatest durability for their products. Their experience of nearly twenty years in the business of manufacturing jet apparatus and the reputation acquired is a guarantee of all the claims made by them.

For further information address the Hancock Inspirator Company, Boston, Mass.

PAGE WOVEN-WIRE FENCE COMPANY.

THE effect of hard times on different people in business is very peculiar; some men seem to fall into a state of bewilderment, and rush to and fro without any definite purpose; others act upon the lawyer's maxim, "When you do not know what to do, do nothing." The conduct and conversation of some men during periods of depression would lead you to think that they never expected to do business again, but intended to quietly fold their hands and dry up. The latter they often do, while those who follow the advice of Livy, and "assume in adversity a countenance of prosperity," are the class of people who usually come out ahead. Now, whatever may be our opinions about the McKinley or the Gorman tariff, the prospects of business, or any other question, this much is true: that most of us must continue in business whether times are good or bad. Evidently the company whose name is at the head of this article are acting upon this assumption. They are making wire fencing, and mean that the whole world, but especially the railroad portion of it, shall know it. With this object in view, they took the trouble to be adequately represented at the recent Road Masters' Convention, which was held in New York. Mr. P. O. Fisher was on hand, prepared to show the merits of their products, and their facilities for fencing in anything, from a cemetery lot to a trans-continental railroad. They have also adopted the plan of publishing very attractive full-page advertisements in the railway papers, one of which appears on page xxxiv. of this issue. They have had photographs made showing specimens of their fence and its use along the lines of railroads. One of these is a view on the Lake Shore Railroad, and represents one of its fast mail trains running at full speed protected by this woven-wire fence. Another picture represents a scene along the line of the same road, which is again enclosed by the woven-wire barrier, but with a contemplative cow and three capricious calves in the foreground. Now, it is obvious from these illustrations that if the protective guardianship of the fence did not exist that the cow and the calves might wander on to the track where the train is, the result of which might be that the train and the cow might change places—that is, the cow would then be on the track dead and the train in the field. Just what does happen when roads are not fenced is shown by the following report of an occurrence on a Western railroad:

SCHNIEDER'S FALLS, September 3, 1894.

To Mr. D. M. Yellek, The Honorable Road Master ——— Railroad:

DEAR SUR: Your humble servant Andy Terry, Section Foreman at the Falls above knows but very little in regards to the killen of the bull on last Tuesday.

But howsuever what right had he there, when he lived two miles beyant the right of way, but nevertheless he came over, along in company with two of his friends, and, in the height of their jollity, they were cavorting the whole of the afternoon up and down the right of way, and presently along comes number 7 and hits the little bull a welt in the back and knocks him to the road below and breaks his bones to atoms—and the bull is dead. That is all I know in regards to the killen of the bull.

Your Humble Servant at the Falls above,

ANDY TERRY,
Section Foreman, Section 22.

P.S.—If there had been Woven-Wire Fence along the road the little bull would still be alive.

This company reports that they have sold 2,497½ miles of fence in 8 months. At this rate, it will not take a great while to girdle the earth.

Recent Patents.

BROWN'S ELECTRIC RAILWAY CAR.

MR. CHARLES BROWN, of Basle, Switzerland, whose ingenious designs of locomotives and other machinery have given him a world-wide reputation, has turned his attention to electric cars, and has taken out a number of patents in this and in European countries. These, it is thought, will be worthy of the careful study of those of our readers who are interested in this class of machinery. The following is one of the most interesting of them:

"The main objects of my invention," he says in his specifications, "are to facilitate the running of street cars upon curves without unnecessary strain or wear upon the running gear, to increase the capacity and efficiency of self-propelling cars of this class, to facilitate access to and inspection of the motors, to protect the motors from mud, dust and moisture, etc.

"It consists essentially of mounting the car upon four independent trucks, each having two wheels in tandem and jointed connections with the car, whereby the wheels of each truck are permitted, independently of the wheels of the other trucks, to adapt themselves in position to curves and irregularities in the track, and of providing each truck with an independent motor.

"It consists also of locating the motor between the wheels of each truck with which it is connected by suitable gearing, and of enclosing the motor and the gearing connecting it with the truck wheels in a casing constituting a portion of the truck frame; and of certain other peculiarities of construction and arrangement hereinafter particularly described and pointed out in the claims.

"In the accompanying drawings like letters designate the same parts in the several figures.

"Fig. 1 represents a motor truck embodying my improvements, partially in side elevation and partially in vertical section cutting the horizontal axis of the truck transversely. Fig. 2 is a horizontal section of said truck in a plane cutting the axis of the truck wheels. Fig. 3 represents two connected trucks, one being shown in end elevation and the other in vertical cross section cutting the horizontal axis of the truck. Fig. 4 is a plan view of a pair of trucks. Fig. 5 is a side elevation of a car mounted upon my improved trucks. Figs. 6 and 7 are diagrams illustrating the manner in which the truck wheels of a car provided with my improvements adapt themselves to curves, a simple curve being shown in fig. 6 and a combined or reverse curve in fig. 7; and fig. 8 is a diagram illustrating the position of the wheels of an ordinary street car with reference to a curve of the same radius as those shown in figs. 6 and 7.

"Heretofore electric motors for street railway service have been applied to cars of a construction like or similar to that of horse cars, which are usually provided with two pairs of wheels rigidly mounted upon axles extending from one side of the car to the other, and rigidly held by their bearings at the same distance apart at both ends, so that in passing around curves, especially of the short radius usually found in street railways, the wheels on one side of the car are compelled to slip upon the rail. This difficulty of adaptation of the wheels to the curves is not serious in the use of horse cars which are made as light as possible and are guided upon the rails by the draft of the animals; but the difficulty is greatly increased and becomes serious by reason of the increased weight necessary in the adaptation of such cars to self-propulsion. The additional load thus placed upon the truck wheels renders their adaptation to curves by slipping on one side of the track much more difficult, and the strain and wear upon the running gears, motors, etc., correspondingly greater. The location of the motors, as heretofore, under the floors of the cars, renders access to the motors for the purpose of inspection and proper care difficult and inconvenient in many ways, and exposes them to dust, mud, etc. The gears are thus subjected to rapid wear, and the insulation of the conductors thus exposed rapidly deterio-

rates and tends to the destruction of the armatures. These difficulties it is the aim of my invention to overcome.

"Referring to figs. 1-4 inclusive of the drawings, *A* represents a truck frame formed in the middle between its wheels, *F F*, with a casing for the electric motor, of which *B B* are the field magnets, *C* the armature, and C^2 the collector or commutator. The frame *A* is pivoted at the middle of its upper side to a horizontal plate, *A'*, so as to turn horizontally on a vertical

FIG. 1.

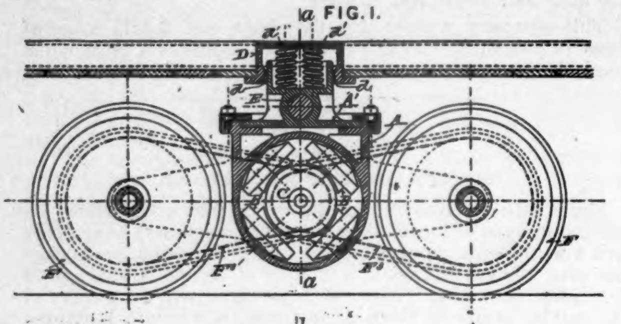


FIG. 2

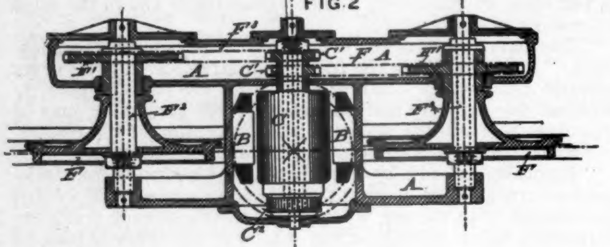


FIG. 3

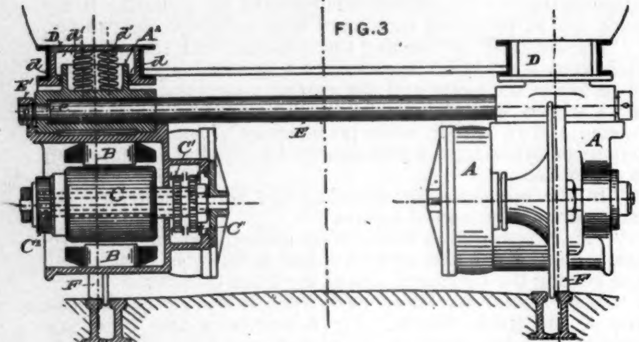
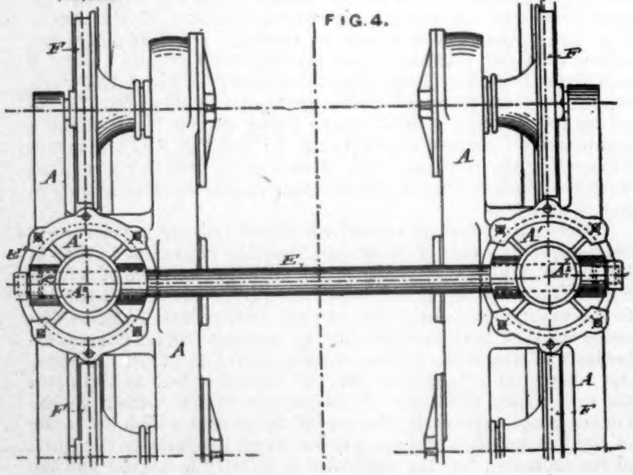


FIG. 4.



axis, *a a*, midway between the points of contact between the wheels *F F* and the rail upon which they run. The plate *A'* is formed on the upper side with a cup, A^2, which is loosely inserted in a cap, *D*, secured in the base of the car. Sufficient play is allowed between the cup A^2 and the inner face *d* of the cap *D*, to permit the plate *A'* to turn a limited distance upon the shaft *E*, upon the end of which it is mounted. The weight of the car body is carried by springs *d' d'* interposed between the cups A^2 and the caps *D*. The corresponding trucks on opposite sides of the car are connected by the shaft *E* and firmly held in their proper relative positions while they are each permitted to turn independently of the other upon said shaft, so as to allow the wheels on either side of the car to follow vertical variations in the rails. The vertical axes *a a*, on which the several trucks turn horizontally to permit the truck wheels to readily follow without binding curves in the track, intersect the axes of the shafts *E*, on which the trucks swing vertically to permit of the wheels following variations in the level of the rails. Each plate *A'* is formed on the upper side between it and the cup A^2 with a sleeve fitted to the end of the shaft *E*, upon which it is held by the shoulder *e* and collar *E'*. This sleeve is allowed a limited amount of endwise play upon the shaft *E*, as shown in fig. 3, to permit the trucks to adapt themselves to variations in the course of either rail. Upon the inner end of each armature shaft are mounted two separate sprocket wheels *C' C'* which are con-

FIG. 5.

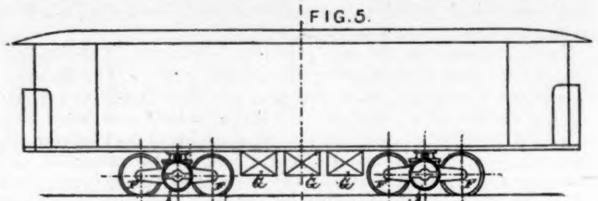


FIG. 6.

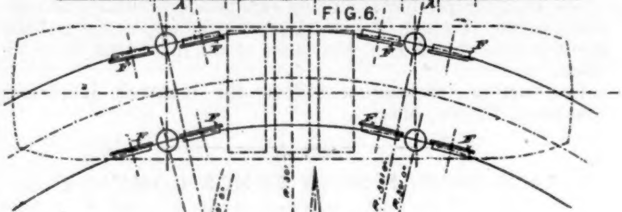


FIG. 7.

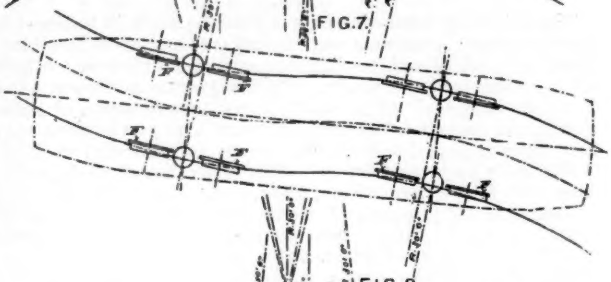


FIG. 8

nected by and transmit their motion through chain belts to sprocket wheels *F' F'* connected with the truck wheels *F F*. The truck wheels *F F* and sprocket wheels *F' F'* are preferably mounted upon sleeves F^2, which turn upon shafts secured at the ends in frame *A*. The sprocket wheels *C' C'* and *F' F'* and the chain belts F^3 F^3 connecting them are enclosed in a case which constitutes a part of the frame *A* and protects them from mud, dust and moisture. It will be observed that the motors are located on the outer sides of the trucks, with their commutators or collectors C^2 outside, thus affording easy access thereto.

"Figs. 6 and 7, illustrating in diagram a car with four trucks, having jointed connections therewith in accordance with my invention, placed upon two curves of 30 ft. radius, one simple and the other compound or reverse, show in connection with fig. 8, which illustrates in diagram a car of the ordinary construction on a curve of the same radius, the great advantage of my improved system of trucks in comparison with the old. It will be observed also by reference to fig. 5 that my system permits of the employment of cars of greater capacity than those at present in use, and that the arrangement of the running gear affords ample space between the trucks for storage batteries *G G*, when they are employed to supply the motive power. This position of the batteries is for many obvious reasons preferable to that in which they are usually placed under the seats or upon the trucks."

The number of this patent is 494,319, and it is dated March 28, 1893.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN JOURNAL.

A WAR BALLOON STRUCK BY LIGHTNING.

(From the London *Times* of September 6.)

AN extraordinary accident, happily not attended with fatal results, occurred yesterday afternoon about four o'clock at the School of Military Ballooning, at Aldershot. A new balloon, larger than any of its predecessors, was to have been "christened" by the Duchess of Connaught. This balloon, to be named after her royal Highness, had been inflated during the morning, and stood ready, gaily decked with bunting. It had been arranged that the Duchess was to cut the ropes retaining the balloon, and that Lieutenant Baden-Powell, of the Scots Guards, and two sergeants of Royal Engineers were to make a free ascent. The *Flo*, the smallest military balloon, containing 4,700 cub. ft. of gas, was also inflated, and bore a large royal standard. As soon as the royal party, consisting of the Duke and Duchess of Connaught and staff, arrived on the ground, this smaller balloon was sent up captive as a royal salute. Lieutenant Blakeney had intended to ascend in it, and had actually got into the car; but as at this moment some sudden strong gusts of wind arose and large drops of rain began to fall, it was decided to send up the balloon without any one in the car. The *Flo* then made a beautiful ascent with its large standard just as the royal party entered the grounds, where they were received by Colonel Sir A. Mackworth, Colonel Templer, Lieutenant Baden-Powell and other officers.

As the rain began to descend more heavily the party repaired to the storehouse, and very shortly afterward the accident happened. The balloon was held by a wire cable about 200 ft. long, fixed to the drum on the balloon wagon. Suddenly it was seen to be struck by lightning, a blue light surrounding the lower part of the balloon for some seconds, and then a flame shot up from the ignited gas, and the balloon fell precipitately to the earth amid a loud peal of thunder. Loud shouts from the sappers forming the detachment at the wagon attracted attention, when it was seen that three of them were rolling on the ground apparently in intense pain. It seems that the men were about to haul the balloon down by winding in the winch, the handles of which are covered with brass, when suddenly all who had hold of the winch were struck down. Every assistance was immediately rendered to the injured men, the Duke of Connaught himself running to the spot and covering one of the men with his own great coat. It was soon seen that, though evidently in great agony, none of the sufferers were very seriously injured. One, a bugler, had the inside of his hand rather badly burned; but the worst case of the three showed no external signs of injury. The car of the balloon, which contained a heavy bag of ballast, fortunately fell without doing any damage. On examination it was found that all the upper part had been burned away, though the metal valve was almost uninjured. Had any one been in the car, even if he had escaped uninjured from the electric shock, he would have had a terrible fall.

The thunder-storm did not last long, but it was deemed advisable to postpone any further experiments. About an hour after the occurrence two of the injured men were taken by ambulance to the hospital, still being apparently in great pain. No similar accident has ever happened before to an English war balloon, though a somewhat similar incident occurred some years ago in the case of a military balloon in Italy.

A subsequent report said that the three men who were injured were progressing favorably, and no serious result or disablement was anticipated.

NAVIGABLE BALLOON AT THE ANTWERP EXHIBITION.

THE chief point of difference between this balloon and all those which have preceded it is in the method of applying the motive force. Instead of turning the propeller by hand, or by steam or other power generated in the car, it is to be worked by electricity, conveyed to the balloon through a flexible cable from dynamos at a central station. Practically, the principle is the same as with the electric tramways, except that the balloon will resemble a tramcar without brakes; but it will be subjected to another difficulty from which tramcars are exempt: it will not always be easy to maintain electric connection, while it will be extremely difficult to re-establish it if accidentally interrupted while the balloon is in the air.

The electricity is generated by a pair of 200-H.P. gas-engines, made by Messrs. Fielding & Platt, driving dynamos which, with switches and other electric fittings, have been supplied by the Oerlikon Works. To obtain gas for these engines, as well as for inflating the balloon, a complete plant has been erected by the Dowson Economic Gas & Power Company, of Westminster.

It was at first intended that the balloon should travel from the Exhibition to the Bourse, on the roof of which there was

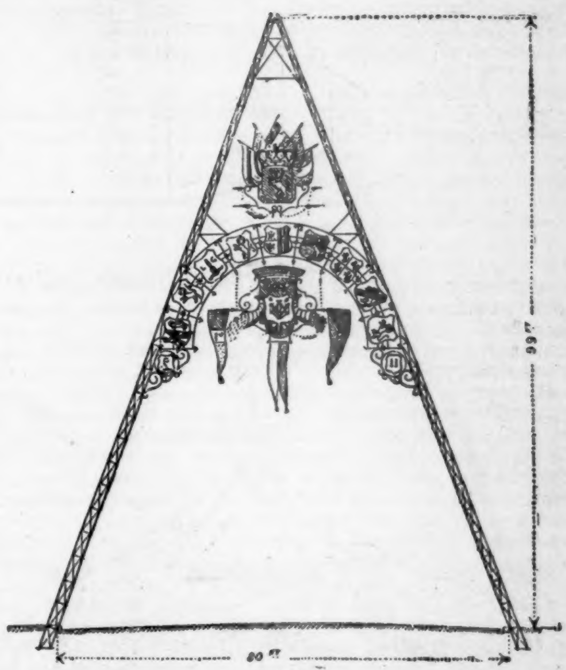


Fig. 2.

TROLLEY POLE FOR NAVIGABLE BALLOON.

to be a station; it was also proposed in some instances to carry the cables on the tops of existing telegraph poles; but the postal authorities not only refused to sanction the use of the poles, but objected to the cables crossing any lines of wire, so a shorter and straighter route had to be selected. It was then decided—see dotted line on fig. 1—to go straight down the Rue Nationale, which enters the Place Verte on the opposite side to the Cathedral, to turn the balloon above the Place Verte, and to return by the same route to the starting-point. Six steel lattice trestles, 100 ft. high, were erected last May to carry the cables. They span the road from pavement to pavement, having an average width of 80 ft. Fig. 2 shows the trestle at the end of the Rue Nationale furthest from the Exhibition; the others are less ornate. They are all made of $3\frac{1}{2}$ in. by $3\frac{1}{2}$ in. by $\frac{3}{8}$ in. angles, with 2 in. by $\frac{3}{8}$ in. flat plates; the legs being 20 in. square at the bottom, and 12 in. square at the top. They were each put up in one piece, and the method of erection was primitive. The apparatus consisted of two pairs of sheer-legs let into timber sills. Between the tops of the legs were inserted derricks, reaching a few feet down, and secured by planks bolted across; between the legs at the bottom were wooden windlasses with four square holes at each side. In these holes workmen had to insert wooden capstan bars, climb up, and by means of their own weight hanging on the bars, turn the windlasses. The arrangement

of the top of the trestles will be seen more clearly from the drawing of the trolley, figs. 4 and 5. The current is conveyed from the generating station by three parallel cables of galvanized steel wire 1 in. in diameter. These, which are each 1,400 yds. long, are in one piece, and are made by Messrs. Bullivant & Co., of Mark Lane.

The general arrangement of the balloon is shown on fig. 3. It is made of linen, specially woven for the purpose, and coated with three layers of varnish. Instead of a net, an outer envelope of the same linen is used; the weight of the double covering being about 4 tons. It is spindle shaped, 57 ft. in of *papier-maché*, and although it is capable of transmitting 125 H.P., its weight is a little under a ton. The screw has four blades, its diameter is 26 ft., and M. Leon Champy, the inventor, has calculated that in calm air the balloon will be able to travel 25 miles an hour, and that consequently he will have sufficient force at his command to be able to drive the balloon against a strong wind. The connection between the three cables and the dynamo in the car is made by an elastic cable, which passing over a drum with an automatic coiling arrangement in the car, terminates in the trolley shown on fig. 4. The captain's station is in the cylindrical portion of

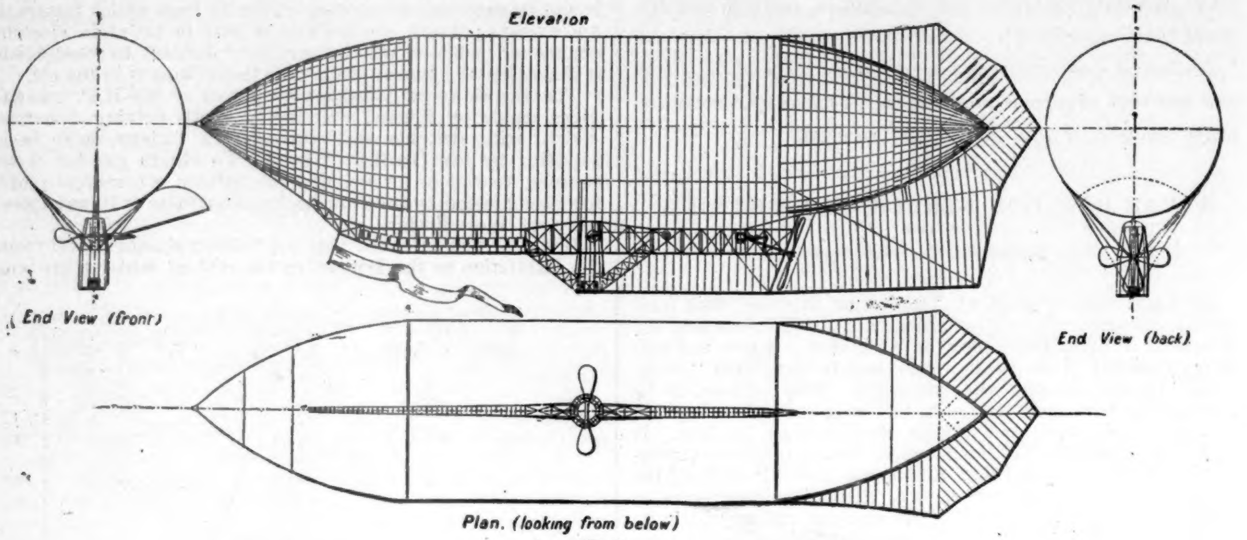
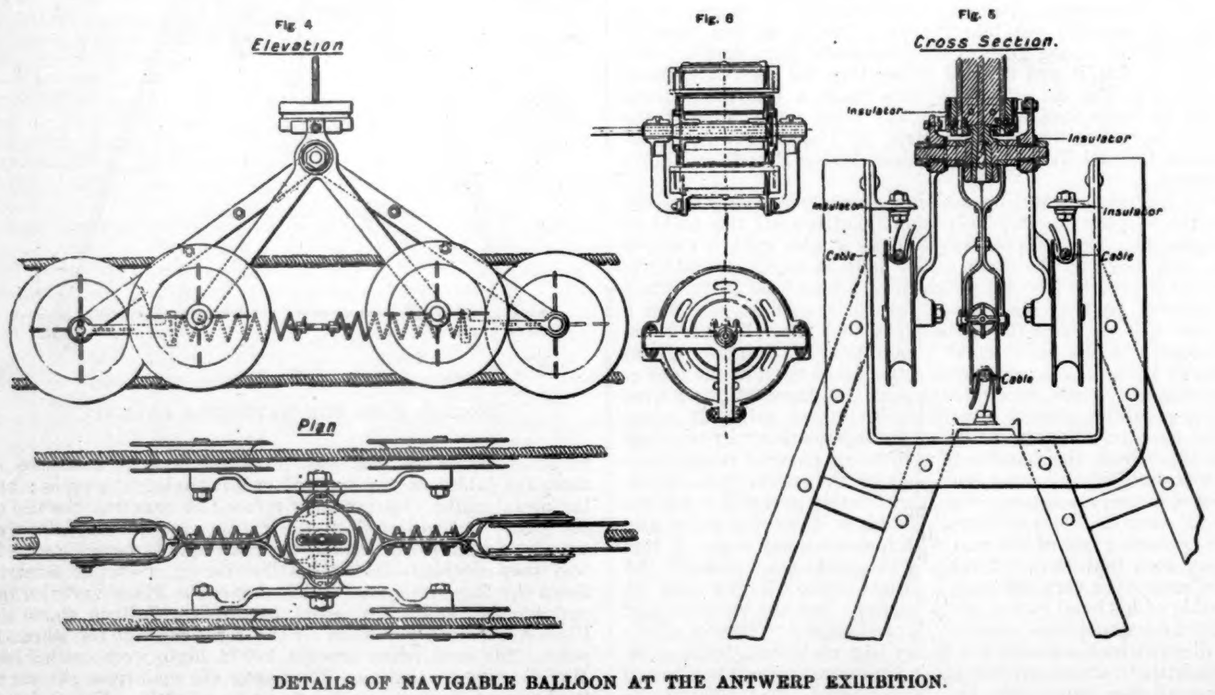


Fig. 3

THE NAVIGABLE BALLOON AT THE ANTWERP EXHIBITION.



DETAILS OF NAVIGABLE BALLOON AT THE ANTWERP EXHIBITION.

diameter, and from the foremost point to the end of the rudder measures 284 ft. Its cubic capacity is 500,000 ft. A valve at the top for letting out the gas has a *papier-maché* frame. It is 4 ft. in diameter, and weighs only 70 lbs. The car is made of steel gas piping, covered with wickerwork, and, as may be seen by the illustration, it is of very peculiar shape. The center is cylindrical, 8 ft. in diameter, and reaches down to much lower than the front and back portions. Of these the front is intended for passengers; it is entirely closed, but with windows. The back is for the crew, and contains the dynamo for transmitting the power to the screw; it is shown in fig. 6, and is also from the Oerlikon Works. Its casing is the car, and from it he will be able to increase or diminish the speed of the balloon, as well as to raise, lower, and steer it.

Antwerp is not the most suitable locality that could be found for aeronautical experiments, as the sudden gusts of wind from across the Scheldt will make steering more difficult than it would be in a steady breeze. It is also to be regretted that a course could not be chosen in which it was not necessary to make such a sudden turn of the balloon, as will be required at the Place Verte, and that the experiment was not first tried with a smaller balloon, so that the resistance to side winds might be less. Still, we hope to be able to report in a few weeks that M. Champy has had a satisfactory trial run,

for it is certain that if aerial locomotion succeeds at Antwerp, it will soon be tried elsewhere over a longer course.—*The Engineer.*

THE DEVELOPMENT OF AERIAL NAVIGATION.*

By Hiram S. Maxim.

In 1890 I tried a series of experiments with a view of ascertaining how much power was required to perform artificial flight. An account of these experiments written by myself, and entitled "Aerial Navigation—the Power Required," appeared in the *Century Magazine* of October, 1891. The apparatus used in these experiments was constructed with great care and was provided with all sorts of delicate instruments which enable me to ascertain definitely the exact power required for performing artificial flight on the aeroplane system driven by screw propellers.

As is well known, when one flies a kite the cord holds the kite against the wind. The wind passing on the under side of the kite strikes it at an angle and raises the kite into the air. If the wind be blowing at a high velocity—say 35 miles an hour—the kite will lift from 1 lb. to 5 lbs. per square foot, according to the angle at which it is held in the air. If the angle be slight, the amount of strain on the cord necessary to hold it against the wind will be found considerably less than the weight of the kite and the load which it is able to lift, particularly so if the cord pulls in a horizontal direction instead of at an angle. It is also well known that if a kite be propelled in a calm through the air, say at the rate of 35 miles an hour, the effect is exactly the same. Suppose now, instead of the cord for holding the kite against the wind or for propelling it against still air, that a screw propeller should be attached to the kite and that it should be driven by some motor. If the screw propeller could be made to give a push equal to the pull of the kite, and if the machinery for driving it should be no greater than the weight that the kite would be able to carry, we should have a veritable flying machine.

In my first experiments to ascertain the power required, the aeroplanes employed were formed of thin pieces of wood, the under side being slightly concave and the top side slightly convex. These aeroplanes I was able to propel round a circle 200 ft. in circumference at a speed say from 20 to 90 miles an hour, and with the planes at any desired angles. When the inclination was 1 in 14 it was found that a thrust of 5 lbs. on the screw would lift 14 times 5 lbs., or 70 lbs., on the plane. It was also found in these experiments with a plane set at an angle of 1 in 14, that as much as 133 lbs. could be carried with the expenditure of 1 H.P. These experiments, which were very full and complete, and which embraced many different kinds of screw propellers and aeroplanes, demonstrated that a two bladed wooden propeller with a pitch slightly greater than the diameter, was the most advantageous, the propelling power being very great and the loss by slip comparatively small. Narrow aeroplanes slightly concave on the under side, set at a slight angle and driven at a high speed, were found to be the most efficient, and any distortion or bagging of the aeroplane increased enormously the power required.

Having ascertained experimentally the power required, I at once commenced experiments with a view of developing the necessary motive power. Everything considered, I believe that steam power would be more efficient for the weight than any other source of energy. First I made two pairs of compound engines, the high-pressure cylinders being 5 in. in diameter, the low-pressure cylinders 8 in. in diameter, and all having a stroke of 12 in In order to make the engines as light as possible, the cylinders were made about $\frac{3}{32}$ in. thick, of a high grade of fluid compressed steel. The valve chambers and passageways were made of seamless steel tubes, the whole being neatly riveted together and brazed with silver solder.

The crank shaft was of comparatively large diameter, but hollow and of highly tempered steel. All the piston and valve rods, and also the framework of the engine, were constructed of hard and thin tubular steel. When the engines were finished they were found to weigh 300 lbs. the pair, or 600 lbs. in all. The high-pressure cylinder was made with a considerable amount of clearance, so as to avoid danger if water should go over with the steam, and the piston valves were made to cut off at $\frac{3}{4}$ stroke, while steam was cut off in the low-pressure cylinder at $\frac{3}{4}$ stroke. Believing that on some occasions I might require to put on a tremendous spurt, I placed a kind of an injector valve between the high-pressure steam directly from the boiler and the exhaust from the high-pressure cylinder. This injector was provided with a spring value regulated in such a manner that in case the boiler pressure should rise above 300 lbs. to the square inch, instead of blowing off steam at the safety-valve, the steam would open a passage directly into the low-pressure cylinder, and, as the passageway was annular and arranged to be more or less large in proportion to the steam passing, the steam in falling from a high to a comparatively low pressure was made to do a certain amount of work on the exhaust steam, thus increasing the pressure in the low-pressure cylinder without greatly increasing the back pressure in the high-pressure cylinder. This is a new feature, which, I think, has never been used on a compound engine before.

The first steam generator was constructed of a very large number of small and thin tubes. It was constructed so as to admit water at one end of the series and to draw steam from the other end, and to so regulate the fire as to convert about 90 per cent. of the passing water into steam. This boiler was of great lightness, not weighing without its casing more than 300 lbs., and was heated by 50 sq. ft. of flame; but it was found impossible to so regulate the fire and the water supply as to have comparatively dry steam without destroying some of the tubes. If twice as much water as is evaporated was pumped through the boiler, it stood the heat fairly well; but upon any attempt being made to reduce the quantity of water, some of the small tubes, which were of copper, would invariably burst. This boiler was, however, remarkable because steam could be raised in about 10 seconds, and on some occasions an ample supply of steam was made to run the engines up to 300 H.P.

The first boiler having failed, I at once determined to make a boiler on a new plan, but before doing so I tried a series of experiments so as to be sure of my ground in my second attempt. I obtained a quantity of copper tubes $\frac{3}{8}$ in. in diameter, $\frac{1}{50}$ in. thick and 8 ft long. Four of these were connected together and provided with a forced circulation; they were then placed in a white-hot furnace and made to evaporate at the rate of $26\frac{1}{2}$ lbs. of water per square foot per hour at a pressure of 400 lbs. to the square inch. Having stood this test, a single tube was placed in a white-hot furnace similarly connected, with a view of finding the bursting pressure under steam. It exploded at 1,650 lbs. to the square foot. Some hundreds of tubes were then tested with one ton per square inch pressure of cold kerosene oil, and as none of them showed any signs of leaking, the new boiler was constructed of these tubes. The general form was somewhat similar to the water-tube boilers employed on torpedo-boats in France and England, except that the tubes were relatively much longer for their diameter and had twice as many bends in them, and to insure circulation a down-take for the water outside the fire-box was provided. The feed-water in coming from the pump passed through a very elaborate network of fine copper tubes immediately over the boiler and at a pressure 30 lbs. greater than the boiler pressure. A spring valve nozzle was interposed between the feed-water heater and the down-take for the water in such a manner that the escaping force of the water operated powerfully on the surrounding water in the down-take, and thus secured a very rapid circulation through the long and slender tubes which formed the main heating surface of the boiler. This new boiler has proved itself to be very efficient indeed; the network of very fine tubes which forms the feed-water heater greatly reduces the temperature of the escaping products of combustion, so that the heating of the top of the casing of the boiler is never great enough to burn paint off the smokestack. The new boiler was first tested to 410 lbs. cold water pressure, and then to 325 lbs. steam pressure. Having completed the new boiler it was placed in position, and experiments commenced with petroleum burners. The new boiler had a very much reduced fire-box. Whereas the first experimental boiler had what might be called 40 sq. ft. of grate surface, the new boiler had only 28 sq. ft. In ordinary boilers heated by petroleum the furnace is supplied with one or two very powerful jets, burning against brickwork or fire clay. This, of course, would be quite out of the question with a flying-machine boiler. Moreover, with such a light boiler it was not advisable to have a very intense flame; what was necessary, of course, was a very large and even flame, so as to heat all tubes equally. The first burners experimented with worked all right for about 100 H.P.; but whenever any attempt was made to increase the flame, great unevenness in the flame occurred, some parts of the fire-box being filled with flame, while other parts had no flame at all. After much experimenting I finally decided to use naphtha, 72° Beaumé.

The naphtha was pumped into a small and exceedingly light vertical boiler, where it was heated with a flame generated from part of its own contents arranged in such a manner that whenever the pressure of the gas or the vapors of petroleum exceed-

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ed 50 lbs. to the square inch the flame was automatically shut off, while if the pressure fell slightly below this the flame was turned on so that, no matter how much gas or vapor was drawn from the boiler, the pressure remained constant. This small boiler was suspended by springs in such a manner that whenever the weight of the contents exceeded 40 lbs., it moved the boiler slightly downward, which operated upon an escapement on the pumping mechanism in such a manner that when the weight was greater than 40 lbs. the stroke of the pump was diminished; while if the weight was less than 40 lbs. the stroke was increased. This apparatus was found to work admirably; and no matter how much or how little gas was drawn from the generator, the weight of liquid and pressure of gas always remained constant. The vapor was led from the generator through a pipe in the furnace, where it became superheated, and then was blown through a species of an injector into the furnace, sucking a large quantity of air through a suitable opening, which could be regulated so as to make the gas of any desired density.

Many burners were experimented with, the first one having as many as 14,000 jets; the one finally adopted had 7,650 burners, and was so arranged that any amount of gas might be consumed without any unevenness, smoking, or blowing. Having perfected my boiler, my gas generator, and my pumping apparatus, so that all worked smoothly and automatically, I attached a pair of very large and carefully made linen-covered wooden screws to the screw shafts. These screws were 17 ft. 10 in. in diameter, and had a slightly increasing pitch, the mean pitch being rather more than 16 ft. It will be understood that the boiler was placed upon a platform about 8 ft. wide and 40 ft. long; that the engines and screws were held by strong tubular brackets above the rear end of this platform, and that the whole was mounted on four steel wheels; that there were springs interposed between the axletrees of these wheels and the platform; and also that there were vertical tubes and wires attached to the platform which held the large aeroplane, which is about 30 ft. × 50 ft., in position.

At the same time that the experiments were going on with the burners and boilers, a railway track 1,800 ft. long was being laid, and the framework of the machine was being brought to a state of completion. Upon moving the machine on to the track, tying it up and attaching it to a dynamometer, I filled the boiler with water, got up steam with a slow fire in about 3 minutes and started my engines, when everything was found to run very smoothly indeed.

With 200 lbs. pressure to the square inch, the thrust of the screws was about 1,400 lbs., but by running the pressure up to 325 lbs. to the square inch, the thrust of the screws went up in the first instance to 1,160 lbs., and finally in a later trial to 1,260 lbs. These experiments should have been tried on a railway track of considerable length, but as I was only able to get a clear track of 1,800 ft., it was found necessary to provide suitable mechanism in order to bring the machine to a state of rest without injury. The best apparatus for this purpose was found to be a series of very strong ropes stretched across the track, each end of the rope being attached to the capstan, and each capstan being provided with a strong plank which acted as a fan. This apparatus stopped the machine without the least shock.

The first experiments were tried without any cloth on the framework, and it was found that when the machine was liberated it started off very quickly, in fact so quickly that it nearly threw down any one who was standing upon it.

After having tried several experiments with the naked framework, the main aeroplane was put in position and a few runs made, but the bagging and distortion of the cloth was such that it required the full power of the engines with a screw thrust of 2,000 lbs. to drive the machine at the rate of 25 miles an hour, and the lift did not exceed the thrust of the screws. This aeroplane was then removed and a new one substituted. The second aeroplane was made of two thicknesses of cloth completely inclosing the framework and arranged in such a manner that a portion of the air could pass through the lower side and produce a slight pressure of air between the two thicknesses. The top side would therefore bag upward and take the lift, while the bottom side having practically the same pressure on both sides would remain perfectly straight and would not be distorted in the least by running.

The first experiments with this new aeroplane were tried with a screw thrust of about 800 lbs., and the lifting power was actually more than with the old aeroplane with 2,000 lbs. thrust. Upon increasing the screw thrust to 1,200 lbs., the lift of the aeroplane was greatly increased, so that the front wheels barely touched the track. I saw that it would not do to run at a greater speed, so I put on some very heavy wheels, weighing 600 lbs. each, which I believed would keep the machine on the track, even if I ran the engines at full speed. I then greatly increased the thrust of the screw, and, finally, ran over the track with a screw thrust of about 1,500 lbs.; but, unfortunately, I met a slight gust of wind coming from an opposite direction, which lifted the front end of the machine, wheels and all, completely off the track.

This accident, although it did not injure the machinery in the least, showed the weak points in the platform and framework of the machine, and I determined to rebuild it completely and to discard the heavy wheels. While the machine was being rebuilt I put up on each side of the railway track, and about 10 ft. from the rails a second track (inverted) of heavy wooden joists, and provided the new machine with four additional wheels placed at such a height that when the machine was raised 1 in. clear from the lower railway track, these new wheels on outriggers would engage the lower side of the joists and thus keep the machine from going off the track. This arrangement has been found to work exceedingly well. It is certainly a great improvement on the old heavy wheels, which not only made the starting and stopping of the machine more difficult, but also failed in keeping it on the track. The upper rail enabled me to make a large number of runs and to note carefully with suitable instruments exactly how much the machine lifted at various speeds. Having finished a series of experiments and ascertained the lift of the main aeroplane with a great degree of nicety, I placed the fore and aft rudders, which were intended to steer the machine in a vertical direction, in position, and made several runs with these rudders at different angles. They were found to work exceedingly well, and I was able to depress or elevate either end at will. The machine had been provided with 10 auxiliary aeroplanes, which consisted of balloon cloth stretched very tightly on frames, and which could be placed one above the other (superposed) on each side of the machine if required. Of these 10 aeroplanes only four were actually used, the lower ones which extended on either side of the machine 30 ft., and the upper ones which extend 27 ft. each side of the main aeroplane and which bring up the total width of the machine to 104 ft. These long and comparatively narrow planes were found, as expected, to be more efficient foot for foot than the main aeroplane.

The first trials with these planes in position were made on July 31 last on a perfectly calm day, and three runs were made, the first with 150 lbs. pressure of steam per square inch. The speed was 26 miles an hour and the maximum lift 2,750 lbs. The second run was made with 240 lbs. of steam. The speed recorder on this occasion failed to work, but it is probable that the speed was 35 miles an hour. The maximum lift was 4,700 lbs. Then everything was made ready for a final test with practically the full power of the engines. Careful observers were stationed on each side of the track, and I took two men with me on the machine, the duty of one being to observe the pressure gauges, and that of the other to observe and note the action of the wheels on the upper track. The machine was tied up to a dynamometer, the engines started at a boiler pressure of 310 lbs. and with a screw thrust of a little more than 2,100 lbs. Upon liberating the machine it darted forward with great rapidity while the screws rotated at a terrific rate. I turned on slightly more gas, and the pressure almost instantly rose to 320 lbs. to the square inch and blew off at the safety-valve at that pressure. After running a few hundred feet, the machine was completely lifted off the lower rails, and all four of the upper wheels were engaged on the upper or safety rail. After running a few hundred feet in this position, the speed of the machine greatly increased and the lift became so great that the rear axletrees holding the machine down were doubled up and the wheels broken off. The machine then became liberated, the front end being held down only on one side. This swayed the machine to one side, brought it violently against the upper rails, and stopped it in the air, the lift breaking the rails and moving them outward about 10 ft. Steam was, however, shut off before the machine stopped. The machine then fell to the earth, imbedding the wheels in the turf, showing that it had been stopped in the air, had come directly down, and had not moved after it touched the ground. Had this last experiment been made with a view to free flight, and had the upper rail been removed or the wheels taken off, the machine would certainly have mounted in the air and have traveled a long distance if necessary. As it was, the lift certainly exceeded the full weight of the machine, the water, the fuel, and the men by 2,000 lbs., and was far beyond the registering limit of the dynagraphs, the pencil being drawn completely across the paper on the recording cylinders.

These experiments at Baldwyn's Park are the first that have ever been attempted with the machine running in a straight line. The prime object of these experiments has been to demonstrate whether it is possible or not for a large machine to

be constructed sufficiently light, powerful, and efficient to actually lift into the air its own weight and the weight of one or more men. All other flying machines which have ever been built in the world have persistently stuck to the earth, and this is the first occasion in which a machine has ever been made to raise itself clear of the earth. It has been admitted by all scientists that as soon as a machine could be made with motors powerful enough to actually lift it in the air, aerial navigation would become practical. I have demonstrated that a good and reliable motor can be made with sufficient power for its weight to drive a flying machine, that a very heavy flying machine may be made to raise itself in the air with water, fuel, and three men on board; and that it may lift, in addition to all this, 2,000 lbs. It now only remains to continue the experiments with a view of learning the art of manœuvring the machine; and for this purpose it will be necessary for me to seek some large, open, and level plain, and to commence by making flights so near to the ground that any mistake in the steering cannot result in a serious mishap.

MR. MAXIM'S FLYING MACHINE.

Sir Robert Rawlinson "went" for Mr. Maxim after the following fashion in the London *Times* a short while ago. In a letter to that paper the distinguished correspondent said:

"Up to this point the Maxim flying machine is only a wrong-headed, stupid waste of money on an apparatus so far innocent of murder. The notice in the *Times* may, however, lead to a catastrophe. I have witnessed one such in London, and have no desire to see another. Some years ago a Belgian brought over to the Cremorne Gardens a flying machine to be raised into the air by a gas-inflated balloon. This I saw go up, and I also saw it come down with a crash into a street in Brompton. The inventor was alone beneath his machine, and, in the presence of his wife, was killed. It was no great stretch of prophecy to predict this result, neither will it be to predict a similar result to Mr. Maxim if ever he ventures to soar, and does soar, a few yards above his tramway, as there must and will be then a downward crash of frame, sails, boiler and man. The albatross and large gulls of the tropics are, in their flight, the most graceful sights in creation: but in storms they are subject to having broken wings. And how is man to build up a machine to fly by mechanical power like an albatross or gull? The machine noticed in the *Times* this day is, however, evidently a long way from flying."

To this Mr. Maxim replied:

"Similar experiments [to those referred to above] have been made a great many times, but generally the experimenter mounts some high building, jumps off, comes to the ground, and breaks a limb or his neck.

"In my case, however, I prefer to experiment with a machine on the ground. Then if the machine has not sufficient energy in it to sustain itself in the air it certainly will never have an opportunity of falling, because it will never rise; consequently I am quite safe in this respect. If I had taken the first machine which I ever made up in a balloon and dropped it, it would certainly have come to the earth with something like a crash; not, however, severe enough to have killed any one, but still it would have been quite unmanageable in the air. But instead of doing this I kept on improving my machine, increasing the efficiency of my motors and screws, till I actually got a machine which would raise itself off the track on which the experiments were being made.

"I am not experimenting with a view to evolve a machine for carrying passengers and freight, as I think it will be a very long time before a flying machine can be profitably employed for the purpose of carrying coals from Newcastle.

"I am quite free to admit that the navigation of the air is beset with a great many dangers; it is also very dangerous to make high explosives or fire large guns, but it is infinitely more dangerous to be within the range of an enemy's guns. What I propose to do is to enable one to assail an enemy from a distance greater than the enemy will be able to strike back with the most powerful gun in existence. So I think it would be quite as safe for combatants to employ my means of assault as to employ the present means, which necessitate their approaching nearer to the enemy and having to receive its fire.

"I do not know that any one has ever invented a system of warfare which is perfectly safe. It is known now to be possible to make a machine that will actually fly at a very high velocity; so nothing remains to be done except to learn how to manœuvre it. In view of the decided advantage which a flying machine would give its possessor over an enemy, I do not think that in case of war European nations would hesitate to employ them even if one-half of the men navigating them were killed. At the present time no difficulty is ever found in getting volunteers to make a torpedo-boat attack upon a man-of-war—something which is infinitely more dangerous than navigating a flying machine would be, as the latter might be painted black and make its attack at night or in a fog, when it would be quite impossible for the enemy to strike back.

"War, at best, is a dangerous game, and those entering upon it are playing with dangerous instruments, whether they are guns, dynamite, or flying machines. I do not hesitate to say that the European nation which first takes advantage of this new engine of destruction will be able to modify the map of Europe according to its own ideas. Who shall it be?"

RECENT AERONAUTICAL PUBLICATIONS.

We shall hereafter publish brief references to such publications and articles concerning Aeronautics as seem to possess interest for our readers.

Zeitschrift für Luftschiffahrt und Physic der Atmosphere, Berlin, Germany; monthly; specially devoted to Aeronautics.

L'Aéronaute, Paris, France, 91 Rue d'Amsterdam; 9 francs a year to United States; monthly; specially devoted to Aeronautics.

L'Aérophile, Paris, France, 113 Boulevard Sébastopol; 12 francs a year to United States; monthly; specially devoted to Aeronautics.

Practical Flight. C. E. Duryea. *Cassier's Magazine*, September, 1894. Gives an account of some partial successes, and indicates the prospects and uses of a successful machine.

The Empire of the Air. L. P. Mouillard. Smithsonian Report 1892 (issued 1894). A translation and synopsis of a remarkable book upon the flight of birds, published in 1881.

Man Flight near at Hand. J. R. Zuberbühler. Boston *Evening Transcript*, August 11, 1894. Discusses the subject generally, and advances some personal views of the writer.

Scientific Problems of the Future. Lieutenant-Colonel H. Elsdale. *Contemporary Review*, March, 1894. Discusses the conquest of the air as the first of four important problems.

Gliding Flight. L. P. Mouillard. *Cosmopolitan Magazine*, February, 1894. A popular account of the further observations and meditations of the author concerning the flight of birds.

Aeronautical Engineering Materials. R. H. Thurston. *Cassier's Magazine*, September, 1894. Discusses the best materials to employ in order to secure strength combined with lightness.

Revue de l'Aéronautique, Paris, France, 120 Boulevard St. Germain; 10 francs a year to United States; quarterly; chiefly publishes carefully prepared memoirs on Aeronautical matters.

The Problem of Man Flight. James Means. 340 Washington Street, Boston, Mass.: W. B. Clarke & Co. Price, 10 cents. A proposal for promoting experiments with soaring machines.

The Flying Man. Vernon. *McClure's Magazine*, September, 1894. Describes the studies and experiments of Herr Lilienthal and the motor with which he is to carry on his experiments this year.

Notes on Aerial Navigation. V. E. Johnson, M.A. *Westminster Review* (British), September, 1894. Discusses the general question and indicates that Aerial Navigation will become an accomplished fact.

The Development of Aerial Navigation. H. S. Maxim. *North American Review*, September, 1894. Mr. Maxim gives a popular account of his experiments, including the one in July last, in which he actually flew.

New Lights on the Problem of Flying. Professor Joseph de Conte. *Popular Science Monthly*, April, 1894. Article modifying the previous assertions of the writer as to the impossibility of artificial flying machines.

The Prospects of Flying. H. S. Maxim. *National Review* (British), September, 1894. Mr. Maxim describes his experiments, and says that "what remains to be done is to learn to steer and to manœuvre the machine."

Aerial Navigation. J. G. W. Fijnje Van Salverda. Translated from the Dutch by George E. Waring, Jr. New York: D. Appleton & Co. 209 pp., price, $1.25. A summary in popular form of the present development and expectations of success in Aerial Navigation. The author is a distinguished Dutch engineer, now retired.

For Aeronautical Advertisements, see page xxiv.

AMERICAN ENGINEER AND RAILROAD JOURNAL.
(Formerly the RAILROAD AND ENGINEERING JOURNAL.)

PUBLISHERS' DEPARTMENT.

General Notes

The Bridgeport Machine Works, of which Mr. E. P. Bullard has been proprietor, has recently been incorporated under the name of the Bullard Machine Tool Company, E. P. Bullard being President. The business will be continued, as in the past, in the manufacture of machine tools.

The Atlantic Coast Line claims a run made from Jacksonville, Fla., to Washington, D. C., a distance of 780 miles, which, deducting stops, was done in 880 minutes, averaging 53¼ miles per hour; as the stops amounted to 169 minutes, the average time for the whole run was 44.8 miles per hour.

The Consolidated Car Heating Company, of Albany, N. Y., announce that Judge Swan, of the United States Circuit Court at Detroit, in a decision rendered August 21, denied the motion for a rehearing in the Cody patent case, thereby affirming a previous decision of the same court in favor of the Consolidated Car Heating Company of Albany, N. Y.

The Foster Engineering Company, of Newark, N. J., write us to call attention to the fact that in the paper descriptive of the auxiliary machinery of the *Columbia*, published in our issue for September, no mention was made of the use of their reducing valves, which, they say, are placed upon the pipes of each of the auxiliary engines, even the steam jackets of the main engines being so supplied. All of the cruisers of the new fleet are equipped with these valves.

The Youngstown Bridge Company have the contract for two-span four-track bridge for the Baltimore & Ohio Railroad at Bessemer, Pa.; a suspension bridge with eyebar cables, and two braced arch spans over Mill Creek Cañon, in Mahoning County, O., and a large head frame for shipment to Salt Lake City, Utah. They have also several large contracts at Springfield, Ill.; Bell County, Tex., and among other work, several spans in Oregon and some truss work for the American Sugar Refining Company at New Orleans.

The George F. Blake Manufacturing Company has recently closed a contract with the Commissioner of Public Works of New York for 4 high-grade, vertical, triple-expansion, crank and fly-wheel pumping engines, to be operated with 160 lbs. steam pressure. These engines are to be placed in a structure located between High Bridge and Washington Bridge, just west of the new speedway. The company has also recently taken a contract in the city of Boston for a 10,000,000-gall. pumping engine of the vertical triple-expansion type, to run with a piston speed of over 400 ft. a minute. The following naval vessels are also equipped with the Blake pump: the *Columbia, New York, Brooklyn, Minneapolis, Philadelphia, Marblehead, Montgomery, Detroit, Chicago, Boston, Atlanta, Maine, Indiana, Massachusetts, Iowa, Dolphin, Macchias, Castine, Puritan, Miantonomah*, the ram *Katahdin*, and the dynamite cruiser *Vesuvius*

Pintsch Gas in Houston, Tex.—Through negotiations which have recently been conducted by Mr. Clarence H. Howard, the Western representative of the Safety Car Heating & Lighting Company, arrangements have recently been made for establishing an extensive plant in Houston for manufacturing and supplying gas to all the different railroad companies centering there. This gas, as is well known, is manufactured by a different process from ordinary illuminating gas, and is then compressed so that it can be stored in the reservoirs on cars. The proposed plant includes compressing machinery, by which, to quote from a book criticised last month, the gas is "hammered into hard but elastic shape." The paper—the Houston *Post*—to which we are indebted for the above information says of Mr. Howard that he is "a genial, whole-souled fellow." That gentleman is reported as saying that all the railroad men in Houston are pleased at having a gas supply located there. When the compressing plant is completed the people of Houston will find, however, that it is easier to compress Pintsch gas than it will be to "hammer Howard into a hard but elastic shape." He is irrepressible.

The E. W. Bliss Company, Brooklyn, N. Y., report that their European business has been very large lately, and that they have shipped to Switzerland within the last two months a special watch-maker's drop hammer, and several punching presses fitted with sub-presses for watch work, also a No. 1½ toggle drawing press; a large shipment to Germany, to one of the largest clock-making concerns in the world, of tools and machinery for the manufacture of clocks and their cases. France has also received a large shipment of tools for the making of granite enameled ware and kitchen utensils. Several watch factories have also been supplied with tools. Austria has not been behind the others, as she has also received a No. 1½ and 3½ toggle drawing press, a No. 18, 19, 20 and 21 adjustable power press, and a No. 38½ and 39 power press, with a number of dies, and a No. 161 double-action press with dies and special feed for making primers. A large improved automatic perforating press is now nearly completed, and will be shipped to England for the manufacture of perforated metals up to 50 in. in width. This speaks well for American tools in competition with those of foreign make, and the company is greatly encouraged in this direction.